Color Atlas of Urinalysis

Second Edition

Ali Nasser M. Gubran Al-Yafai

BSc. Laboratory Medicine

MSc. Medical Microbiology

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This Atlas was reviewed by

Prof. Dr. Khaled A. Al-Moyed **(MSc, PhD)**

Professor of Medical Microbiology

Faculty of Medicine and Health Sciences

Sana'a University

Prof. Dr. Ahmed M. Al-Haddad **(MSc, PhD)**

Professor in Medical Microbiology and Molecular Biology

College of Medicine and Health Sciences

Hadhramout University

Prof. Dr. Mohammed T. Al-Maktari **(MSc, PhD)**

Professor in Medical Parasitology

Faculty of Medicine and Health Sciences

Sana'a University

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Preface

Despite of the development of automated systems for urinalysis, the routine methods for urinalysis are still the golden standards.

This atlas is designed to meet the needs of the students in laboratory medicine, laboratory workers and others who are interested in urinalysis, so the author cares to make this atlas simple to understand and learning.

The concept behind this venture is to provide a single reference volume with appeal to medical laboratory students at all levels and specialties. The author believes that this atlas will be helpful for them.

This atlas aims to:

- Learn the students the correct methods in collection and processing of urine samples.
- Learn the students how to differentiate between different types of urine sediments.
- Learn the students how to differentiate between the artifacts or contaminants and urine sediments.

There are at least six images for each urine sediment and most images provided in this atlas took years of work and effort by the author, so reader's suggestions and comments will help for further improvement of the atlas in future edition. The author hopes from those who will read this atlas to send their suggestions and comments to author's E-mail that is mentioned previously.

Aden, 2015 ***Ali Nasser M. Gubran Al-Yafai***

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Chapter I

Collection and Handling of Urine Sample

Collection and Handling of Urine Sample

1. Collection of urine sample

The urine sample usually collects by the patient and there are certain important considerations to be borne in mind relative to the collection of urine samples for examination as:

- A random sample is usually sufficient for the performance of most urinary screening tests; but, since the first sample voided in the morning (first-morning) is more concentrated it is usually the sample of choice. Samples collected randomly during the day are sometimes so dilute due to increased fluid consumption that they tend to give a false picture of the patient's health.
- Containers for routine urinalysis should have a wide mouth to facilitate collection from female patients and a wide, flat bottom to prevent overturning. Conical containers are less likely to tip over .
- The container should also be a clean, dry, leak-proof, 100 to 200 ml with lid. Properly applied screw-top lids are less likely to leak than snap-on lids.
- The container should be made of a clear plastic material to allow for determination of color and clarity.
- Waxy–coated cardboard containers should not be used because of the likelihood of contaminating the specimen with fatty materials.
- Pediatric urine collectors of clear pliable polyethylene plastic bags with hypoallergenic skin adhesive to attach to the genital area for male and female infant, the bag may be folded and self-sealed for transportation.
- The following instructions should be given to the patient before collection of urine sample:
  - Instruct the patient to wash his/her hands before and after collection of urine.
  - Instruct the patient to collect the urine smaple without mixing with stool, water or soup or other contaminants.
  - Instruct the patient to run slowly for at least half an hour before collection of urine sample when *Schistosoma haematobium* is suspected .
  - When midstream urine sample is required ask the patient to pass small amount of urine out and pass the remaining of urine to the container.
  - When terminal urine sample is required ask the patient to urinate the last portion of urine into the container.
  - Instruct the patient to place the lid, secure tightly and rapidly transport of urine sample to the laboratory.
  - Instruct the patient to collects about 20 ml of urine. The container should be covered immediately.
- All specimens and request forms must be labeled properly with the patient's name

and identification number, the date and time of collection. There is no problem if the labeling of container occurred before or after collection of specimen.

- Labels must be attached to the container, not to the lid, and should not become detached if the container is refrigerated or frozen.
- Improperly labeled and collected specimens should be rejected by the laboratory, and appropriate personnel should be notified to collect a new specimen.

2. Handling of urine sample

The fact that a urine sample is so readily available and easily collected often leads to laxity in the treatment of the specimen after its collection.

Sample Integrity

The samples should be delivered to the laboratory promptly and tested within 2 hours. A specimen that cannot be delivered and tested within 2 hours should be refrigerated or have an appropriate chemical preservative added.

Sample preservation

- The most routinely used method of preservation is refrigeration at 2 C° to 8 C°, which decreases bacterial growth and metabolism.
- Preservatives that can be used to preserve random screening samples include toluene, formalin, thymol, formaldehyde-generating preservative tablets, and chloroform, boric acid, and chlorhexidine (Table 1.1).

Table 1.1: Advantages and disadvantages of urine preservatives

Preservative	Advantages	Disadvantages
Formalin (1 drop/30 ml urine)	It is good preservative for urinary sediment.	When it uses in too large concentration it will precipitate protein and will give false-positive test for reducing substances.
Toluene (2 ml/100 ml urine)	It uses to preserve ketones, proteins, and reducing substances.	It is not effective against bacteria already present in the urine and it is flammable.
Thymol (one small crystal)	It is adequate preservative for most urinary constituents.	It rarely uses and interferes with the acid precipitation test for protein.
Preservative tablets (1 tablet/30 ml urine)	In low concentration, it is not interfere with the test for reducing substances.	In higher concentrations will result in false positives and increases the specific gravity.
Chloroform	It uses for inhibiting bacterial growth.	It causes changes in the characteristics of the cellular sediment.
Boric acid	It is good preservative to preserve formed elements and preserve urine for culture and sensitivity.	It interferes with the pH reading.
Chlorhexidine	It prevents bacterial growth and is useful as a glucose preservative	None

Fig 1.1: Use a clean, dry, leak-proof and wide mouth disposable plastic container with lid

Fig 1.2 Label the container properly and handover it to the patient.

Fig 1.3 Instruct to the patient how to collect the urine sample.

Fig 1.4 Instruct to the patient to collect at least 20 ml of urine.

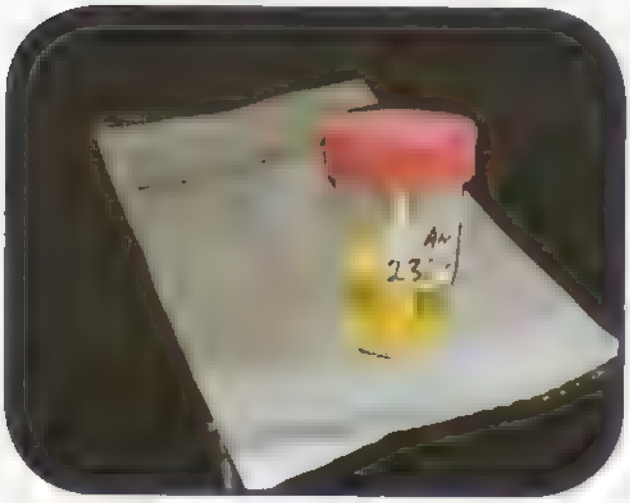


Fig 1.5 Place the urine on the request form.

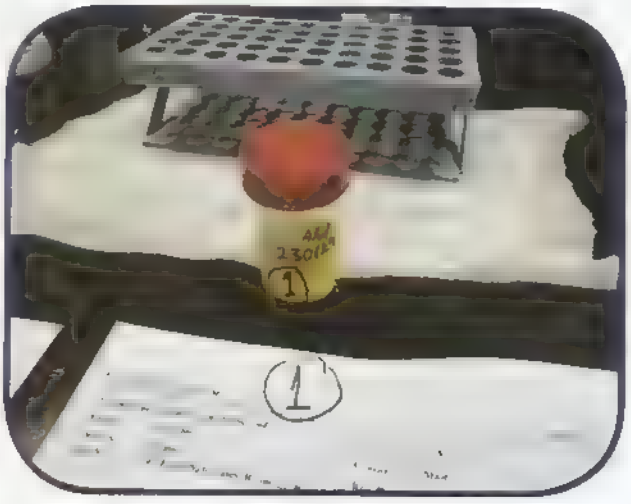


Fig 1.6 Mark the same label on the container and the request form. Don't mark the label on the lid.

Chapter II

Macroscopic Examination of Urine

Macroscopic Examination of Urine

Physical examination of urine

The physical examination of urine includes appearance, color and specific gravity.

Appearance and color of urine

Urine is normally clear straw-yellow in color. More concentrated urine may appear dark yellow. However, the color of urine varies from almost colorless to black as follows:

- Colorless: very dilute urine due to:
  - Recent fluid consumption.
- Cloudy: due to:
  - Crystals
  - Leucocytes (Pus cells)
  - Red cells (smoky)
  - Bacteria
  - Yeasts
  - Spermatozoa
  - Mucus threads
  - Fecal contamination
  - Radiographic dye
- Milky: due to:
  - Many neutrophils (Pyuria)
  - Fat
  - Chyluria
- Pale Yellow: due to:
  - Polyuria (Diabetes insipidus)
  - Diabetes mellitus
  - Dilute random specimen
- Orange: due to:
  - Bilirubin
  - Acriflavine
  - Phenazopyridine (Pyridium)
  - Nitrofurantoin
  - Phenindione

- Dark yellow amber: due to:
  - Concentrated sample
- Green to blue: due to:
  - Pseudomonas infection
  - Amitriptyline
  - Methocarbamol (Robaxin)
  - Methylene blue
  - Phenol
- Red purple to brown: due to:
  - Porphyrins
  - Red blood cells
  - Methemoglobin
  - Myoglobin
- Brown to black: due to :
  - Methemoglobin
  - Melanin
  - Homogentistic acid

Specific gravity

The specific gravity is the ratio of the weight of a volume of urine to the weight of the same volume of distilled water at a constant temperature. It is an indicator of the concentration of dissolved material in the urine; however, it is dependent not only upon the number of particles but also upon the weight of the particles in the solution The specific gravity test is one of the reagent strip tests.

Chemical examination of urine

The chemical examination of urine includes pH, protein, glucose, ketones, occult blood, bilirubin, urobilinogen, nitrite, leukocyte esterase, and strip test method for specific gravity.

The urinalysis offered by laboratories depends on the type of dipstick that is used. Completion of urine chemistry using reagent test strips occurs in 2 minutes.

There are many methods for chemical examination of urine but the rapid method is a reagent strip

Reagent strip

A reagent strip, also called a dipstick, is a narrow strip of plastic with small pads attached to it. Each pad contains reagents for a different reaction, thus allowing for the simultaneous determination of several tests.

Urine should be tested at room temperature. If the urine specimen has been refrigerated, it

should be brought to room temperature before testing.

The reagent strip tests are performed as follows:

- Completely dip the test areas of the strip in fresh, well mixed, uncentrifuged urine and remove immediately. Care should be taken not to touch the test areas.
- Remove the excess urine from the stick by touching the edge of the strip to the urine container or blot the edge of the strip on a disposable clean absorbent pad. Follow the manufacturer's requirement for maintaining the reagent strip in either a horizontal or vertical position.
- At the correct times, compare the test areas with the corresponding color charts on the container. The strip should be read in good lighting for accurate color comparison.
- Record results as prescribed by your laboratory's protocol.

Preparation of urine sediments for microscopy

- Transfer about 10 ml of well mixed urine to a labeled conical tube.
- Balance two tubes opposite to each other into the centrifuge bucket.
- Centrifuge at 500–1000 g for 5 minutes.
- Pour the supernatant fluid (by completely inverting the tube) without shaking.
- Leave at least 1ml of urine sediments.
- Remix the sediment by finger-flicking the bottom of the tube or by mixer.
- Transfer one drop of the well-mixed sediment to clean dry glass slide by a dropper or by inverting the tube. The drop must be in the center of the slide.
- Apply cover glass and avoid air bubbles.
- Place the slide on the stage of microscope.
- Examine the preparation using the 10x and 40x objective with the condenser iris closed sufficiently to give good contrast and don't use 10x and 40x objective with oil.
- For each urine sediments, 10 fields are examined and the average number or grading is reported based on this 10 fields.

Fig. 2.1: Transfer about 10 ml of well mixed urine to a labeled centrifuge tube.

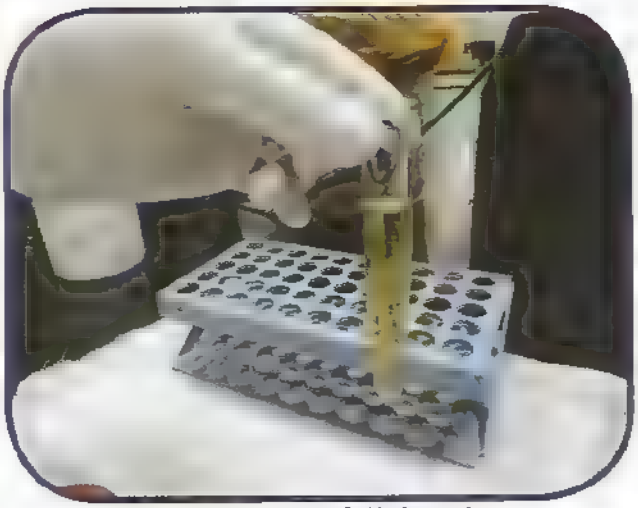


Fig. 2.2: Don't full the tube.

Fig. 2.3: Take one strip and close the bottle of strips immediately.

Fig. 2.4: Completely dip the test areas of the strip in fresh, well mixed, uncentrifuged urine

Fig. 2.5. Care should be taken not to touch the test areas.

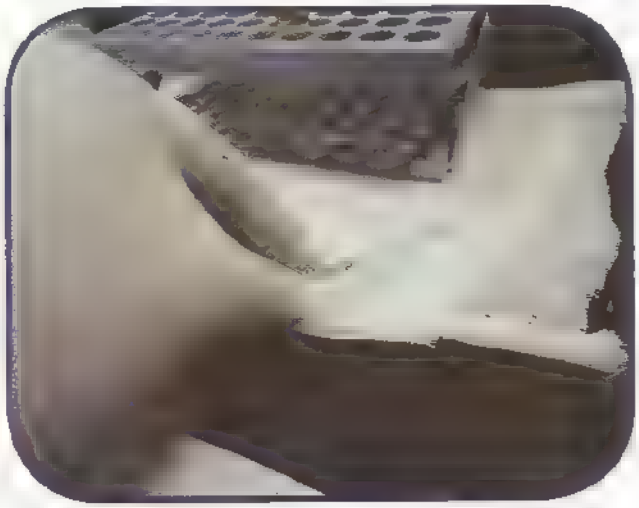


Fig. 2.6: Blot the edge of the strip on a disposable absorbent pad.

Fig. 2.7 Match the test areas with the corresponding color charts on the bottle and recorded the results.

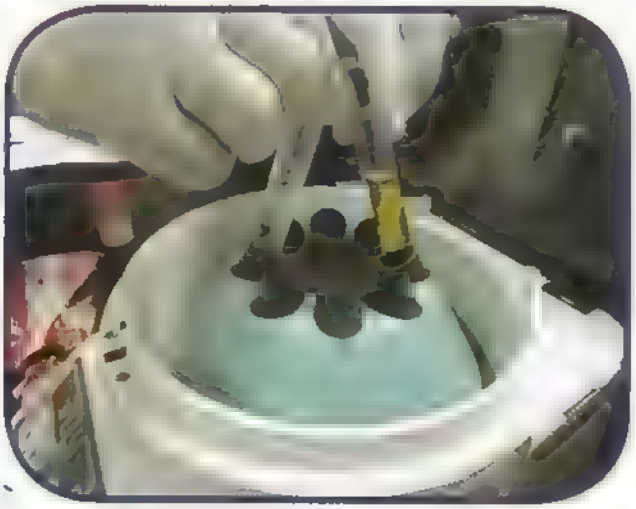


Fig. 2.8: Balance two tubes opposite to each other into the centrifuge bucket.

Fig. 2.9 Cover the lid and Centrifuge at 500 – 1000g for 5 minutes.

Fig. 2.10 Pour the supernatants fluid by completely inverting the tube without shaking.

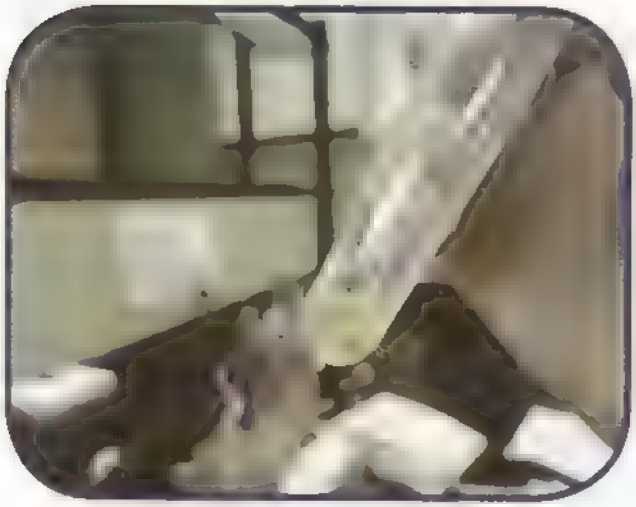


Fig. 2.11: Leave at least 1ml of urine sediments.

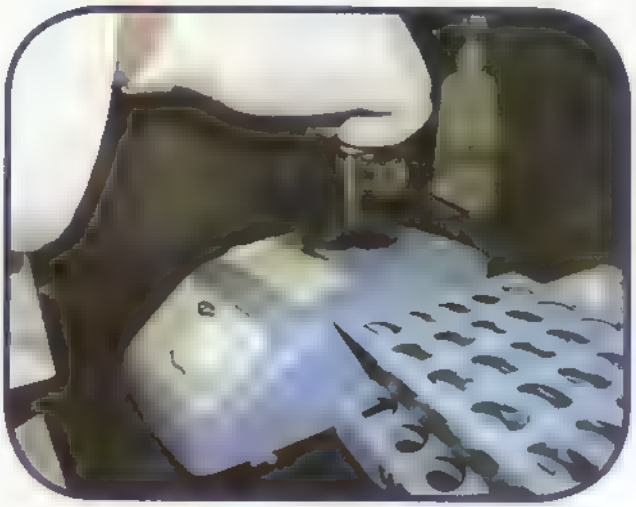


Fig. 2.12: Remix the sediments.

Fig 2.13: Transfer one drop of well-mixed sediments to a slide.

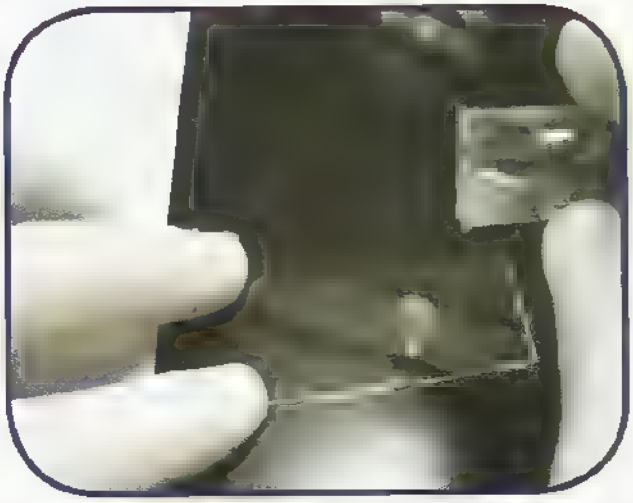


Fig. 2.14. The drop must be in the center of the slide.

Fig. 2.15. Apply cover glass.

Fig. 2.16: Ovoid air bubbles.

Fig. 2.17: Place the slide on the stage of microscope and use the 10x and 40x objective lenses.

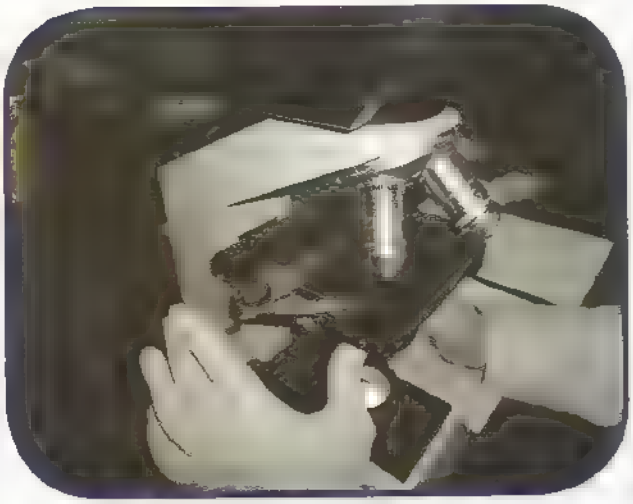


Fig. 2.18: The condenser iris must be closed sufficiently to give a good light contrast

Fig. 2.19: Clear (Colorless).

Fig. 2.20: Milky color.

Fig. 2.21: Cloudy.

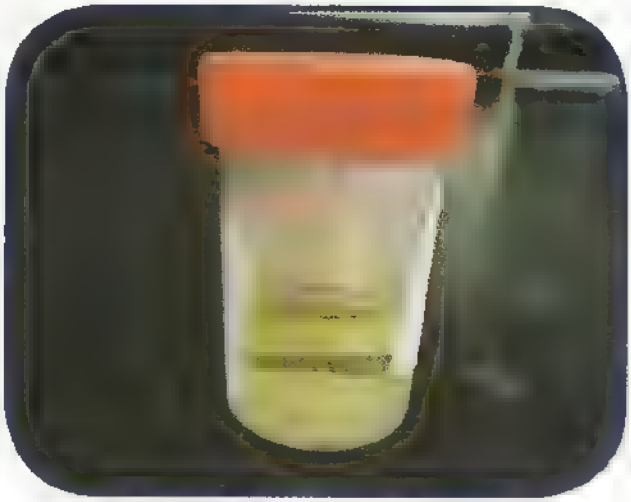


Fig. 2 22: Pale yellow color.

Fig. 2.23: Yellow color.

Fig. 2.24: Orange color.

Fig. 2.25 Red-brown color.

Fig. 2.26: Red color.

Fig. 2.27: Dark red color.

Fig. 2.28: Brown black color.

Fig 2.29: Green color.

Fig. 2.30: Blue color.

Fig 2.31 Bottle contains multitests urine Strips.

Fig 2.32: One strip with ten tests.

Fig 2.33: The suspected results of glucose test.

Fig 2.34: The suspected results of protein test.

Fig. 2.35: The suspected results of specific gravity test

Fig. 2.36: The suspected results of pH test.

Fig 2.37: The suspected results of bilirubin test.

Fig. 2.38: The suspected results of urobilinogen test

Fig 2.39: The suspected results of ketones test.

Fig. 2.40 The suspected results of nitrite test.

Fig. 2.41: The suspected results of blood test.

Fig. 2.42. The suspected results of leucocyte esterase test.

Chapter III

Microscopic Examination of Urine

Microscopic Examination of Urine

The purpose of microscopic examination of urine sediments is to detect and identify insoluble materials present in the urine specimen.

Urine sediments

Urine sediments may be identified in unstained or stained smear. The following sediments may be found in urine specimen:

a. Cells

- Red blood cells
- White blood cells
- Epithelial cells
  - Squamous epithelial cells
  - Transitional epithelial cells
  - Renal tubular epithelial cells
- Other cells
  - Oval fat body
  - Clue cells

b. Casts

- **Non cellular casts**
  - Hyaline casts
  - Granular casts
  - Waxy casts
  - Fatty casts
- **Cellular casts**
  - Red blood cell casts
  - White blood cell casts
  - Renal tubular epithelial cell casts
- **Other casts**

c. Crystals

Crystals in acid urine

- Uric acid
- Cystine
- Amorphous urates
- Sodium urate

- Bilirubin
- Cholesterol
- Calcium sulfate

Crystals in acid and neutral urine

- Tyrosine
- Leucine

Crystals in acid, neutral and alkaline urine

- Hippuric acid
- Calcium oxalate

Crystals in neutral and alkaline urine

- Amorphous phosphates
- Calcium phosphate and dicalcium phosphate

Crystals in alkaline urine

- Triple phosphate
- Ammonium biurate
- Calcium carbonate

Mixed crystals

Drug and radiographic dye crystals

- Drug crystals
  - Sulfa crystals
  - Ampicillin crystals
  - Other drug crystals
- Radiographic dye crystals

d. Parasites

Parasites common seen in urine

- *Trichomonas vaginalis*
- *Schistosoma haematobium*

Parasites rare seen in urine

- Microfilariae
  - *Onchocerca volvulus*
  - *Wuchereria bancrofti*
- *Schistosoma mansoni*
- Hydatid sand

Parasite seen in urine due to sexual transmission or faecal contamination

- *Entrobius vermicularis*
- *Phthirus pubis*
- *Sarcoptes scabei*

e. Miscellaneous structures

- Bacteria
- Yeast cells
- Spermatozoa
- Mucus
- Cylindroid

f. Artifacts and contaminants in urine sediments

- Starch granules
- Pollen grains
- Air bubbles
- Cotton fibers
- Oil droplets
- Fecal materials
- Hairs
- Vegetables fibers
- Glass fragments

Cells

The cells that may be found in urine include:

Red blood cells

- Red blood cells (Erythrocytes) in urine may appear as:
  - Intact: small yellowish discs, darker at the edges (8mm)
  - Crenated: spiky edges, reduced diameter (5–6mm).
  - Swollen: thin circles, increased diameter (9–10mm).
- Normal: 0-3 /HPF.
- RBCs may be misdiagnosed with yeast cells, oil droplets, air bubbles, calcium oxalate crystals (oval form). and white blood cells (WBCs) , therefore a drop of acetic acid should be added to the slide in order to lyse the RBCs.

White blood cells

- White blood cells (Leukocytes) in urine may appear as:
  - Intact: clear granular discs, 10–15mm (the nuclei may be visible).
  - Degenerated: distorted shape, shrunken, less granular and When WBCs expand in a dilute or hypotonic urine, their granules may demonstrate Brownian movement. Cells that develop this characteristic are called "glitter cells
  - Pus: clumps of numerous degenerated cells.
- Normal: 0-8 WBC/ HPF.
- WBCs may be misdiagnosed with renal tubular epithelial cells and crenated RBC.

Epithelial cells

There are three types of epithelial cells may found in urine:

Squamous epithelial cells

- Squamous cells are the largest cells found in the urine sediments.
- Squamous epithelial cells are easily recognized as large, flat and irregularly shaped cells.
- They contain abundant, irregular cytoplasm and a prominent central nucleus about the size of an RBC .
- Normal : few| LPF.

Transitional epithelial cells

- Transitional epithelial cells are two to four times as large as white cells. They may be round, pear-shaped, or may have taillike projections and occasionally, these cells may

contain two nuclei. They appear in several forms, including spherical, polyhedral, and caudate.

- Normal : few| HPF.

Renal tubular epithelial cells

- Renal tubular epithelial (RTE) cells are slightly larger than leukocytes and contain a large round eccentric nucleus and may have rectangular, columnar, round, oval or cuboidal shape.
- RTE cells may be misdiagnosed with spherical transitional cells and granular casts.
- Normal: few| HPF.

Other cells

Oval fat bodies

- Oval fat bodies are usually defined as being renal tubular cells which contain highly refractile fat droplets.
- Renal tubular epithelial cells absorb lipids that are present in the glomerular filtrate, these lipid-containing RTE cells are called oval fat bodies.
- Oval fat bodies may also be macrophages or polymorphonuclear leukocytes that have either ingested lipids or degenerated cells, or have undergone fatty degeneration.
- They then appear highly refractile, and the nucleus may be more difficult to observe.
- Identification of oval fat bodies is confirmed by staining the sediment with Sudan III and examining the sediment using polarized microscopy.
- Oval fat bodies may be misdiagnosed with fat droplets .

Clue cells

- Clue cells are squamous epithelial cells with large number of bacteria adhering to them giving them a 'shaggy' appearance and originate in vaginal mucosa and their presence mostly indicates to *Gardnerella vaginalis* vaginal infection.
- They may appear in urine as a vaginal contamination.
- They are only considered as a clue cell, if the bacteria covered most (but not all) of the cell and extend beyond the borders giving a "shaggy or bearded" appearance.
- They usually detect after staining with Gram stain.

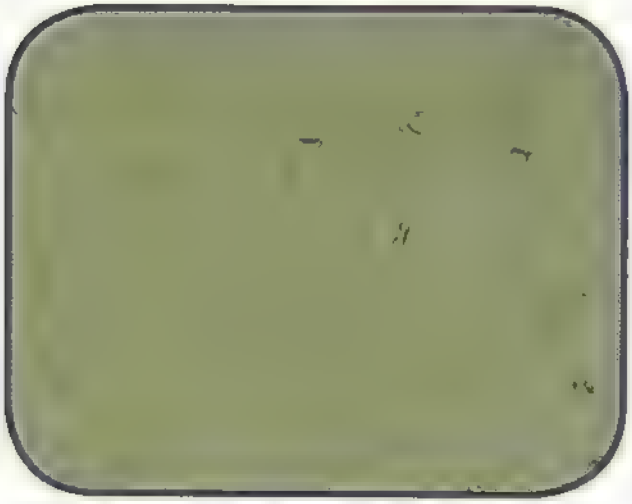


Fig. 3.1a Normal red blood cells. Notice the biconcave disks (400x).

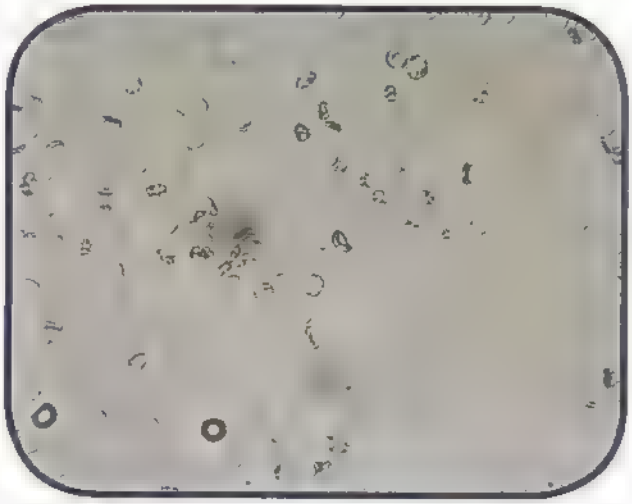


Fig. 3.2a. Swollen and crenated red blood cells (400x).

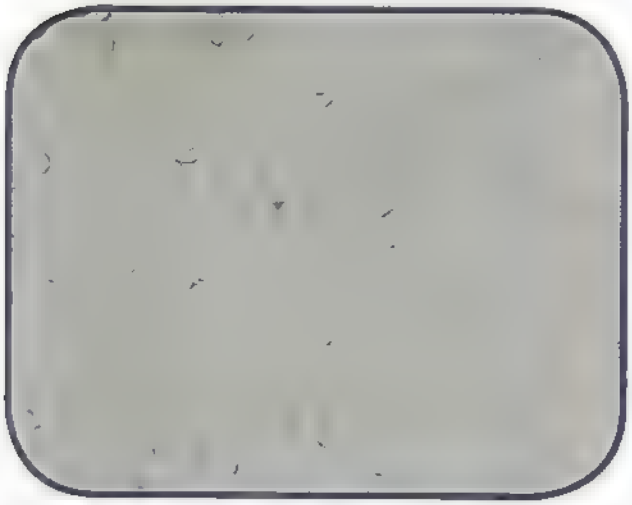


Fig. 3.3a Swollen and ghost red blood cells in diluted urine (400x).

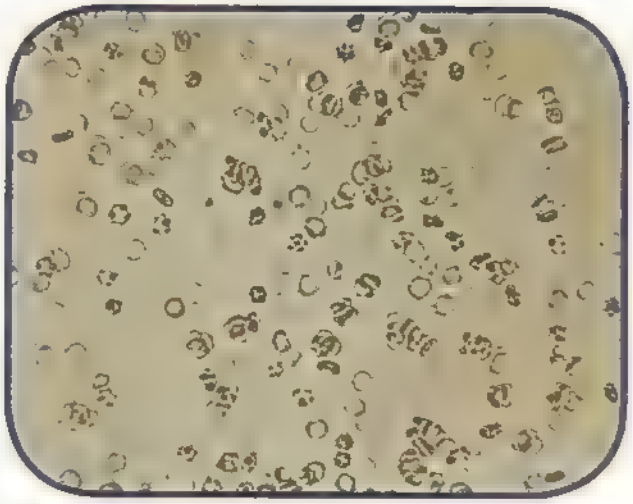


Fig. 3.4a Crenated and Roulex formation red blood cells (400x).

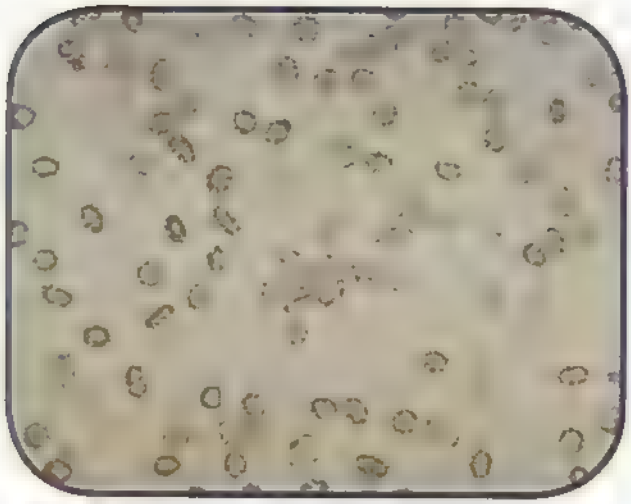


Fig. 3.5a: Crenated red blood cells resemble white blood cells (400x).

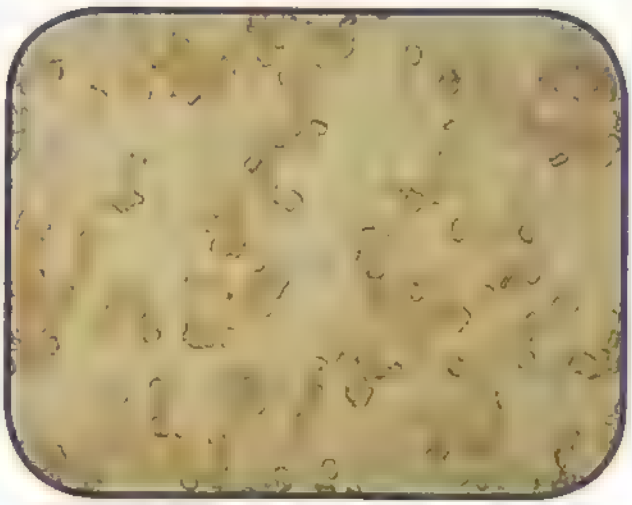


Fig. 3.6a Roulex formation red blood cells (400x).

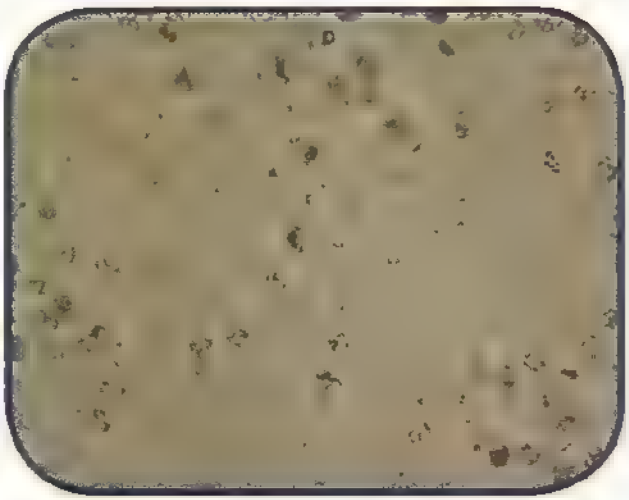


Fig. 3.7a: Some swollen white blood cells. Notice Brownian movement (400x).

Fig. 3.8a: White blood cells (400x).

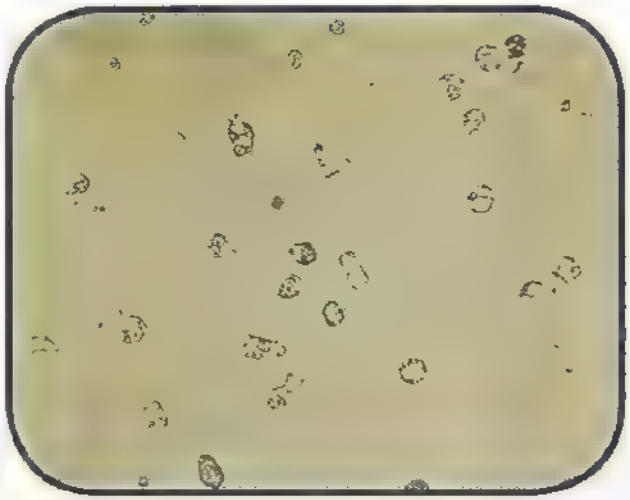


Fig. 3.9a: Degenerative white blood cells (400x).

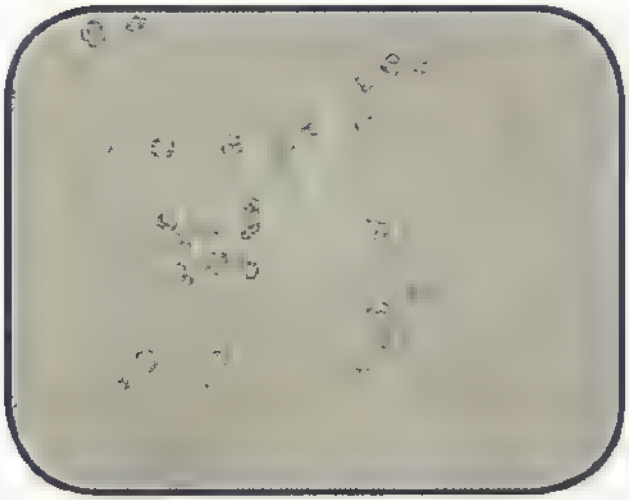


Fig. 3.10a: White blood cells and bacteria (400x).

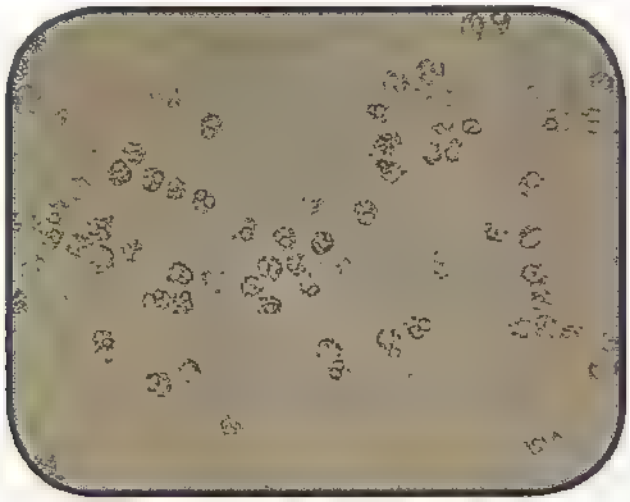


Fig. 3.11a: White blood cells. Notice the multilobed nucleoli (400x).

Fig. 3.12a: Clumped white blood cells resemble WBC cast. Notice the absence of a cast matrix (400x).

Fig. 3.13a: Squamous epithelial cells. Notice the small nuclei (400x).

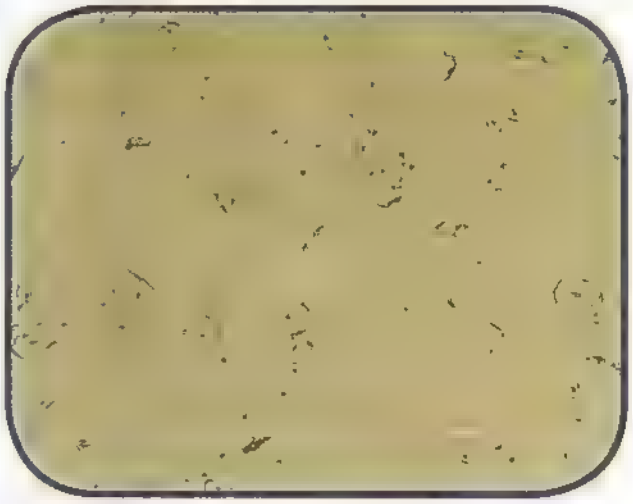


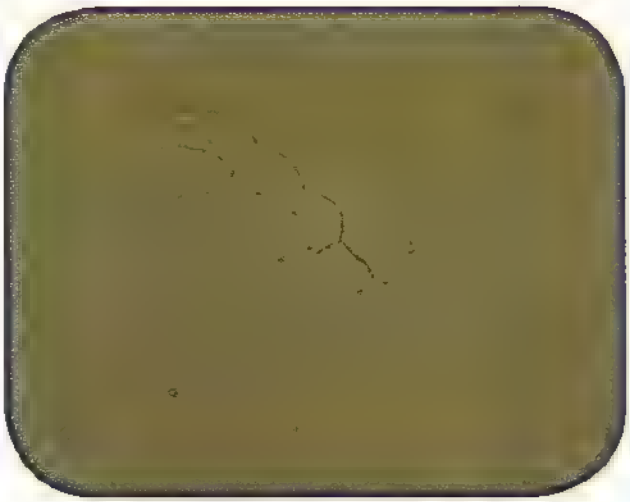
Fig. 3.14a: Squamous epithelial cells (100x).

Fig. 3.15a: Four squamous epithelial cells. Notice one without nucleus (400x).

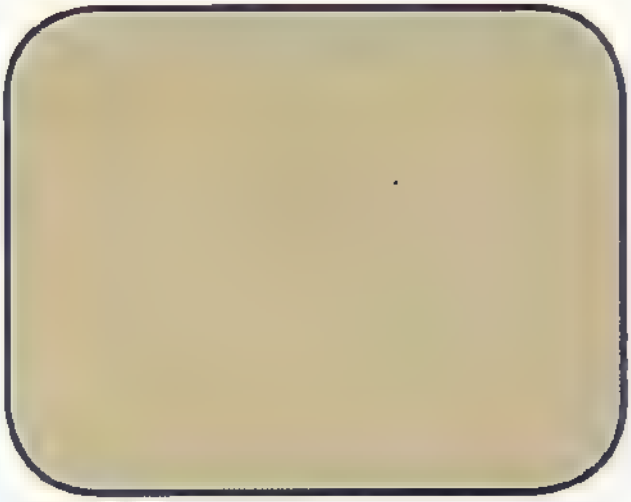
Fig. 3.16a: Two squamous epithelial cells (400x).

Fig. 3.17a: Three squamous epithelial cells (400x).

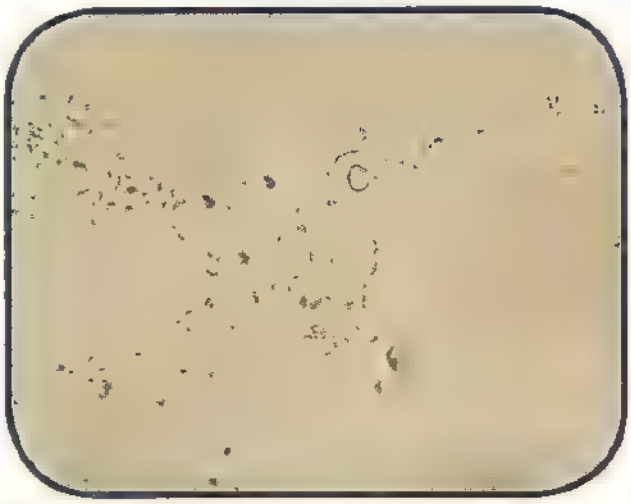
Fig. 3.18a: Two squamous epithelial cells (400x).



3.19a: Eight transitional epithelial cells (400x).

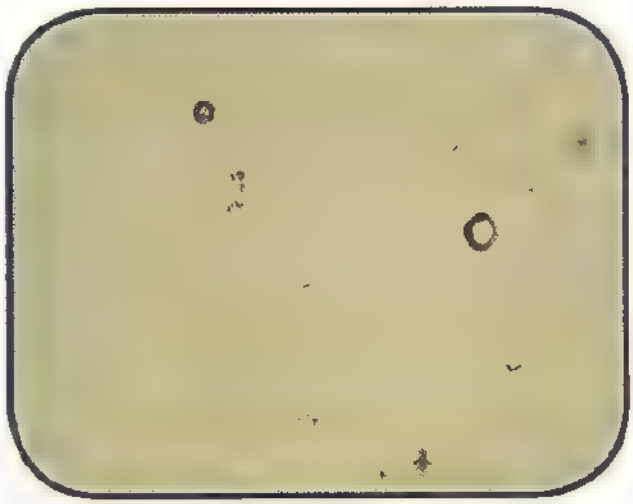


3.20a: Five transitional epithelial cells (400x).



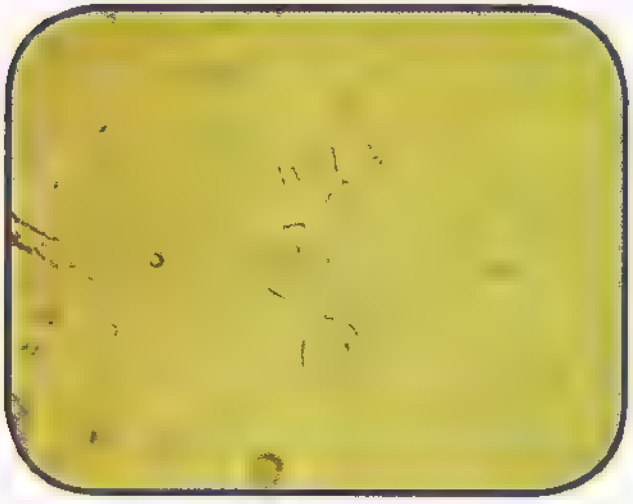
3.21a: Four transitional epithelial cell (400x)

3.22a: Stained transitional epithelial cells (400x).

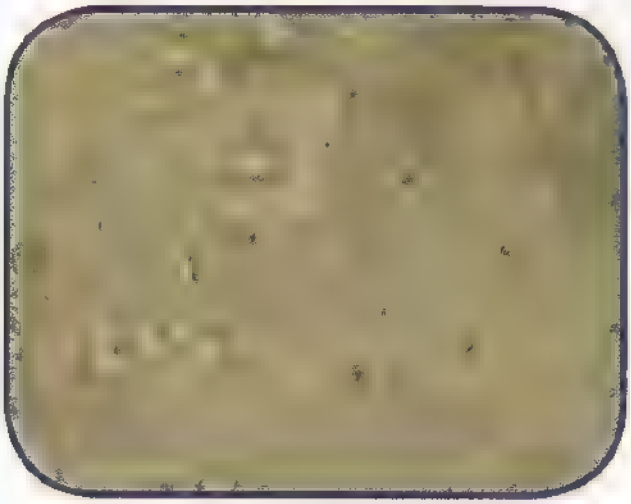


3.23a. Caudate transitional epithelial cells (400x).

3.24a: Caudate and clumped transitional epithelial cells (400x).

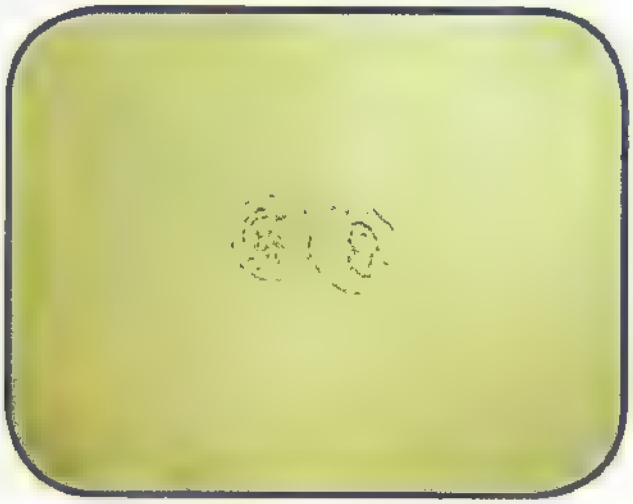


3.25a: Six renal tubular epithelial cells (400x).



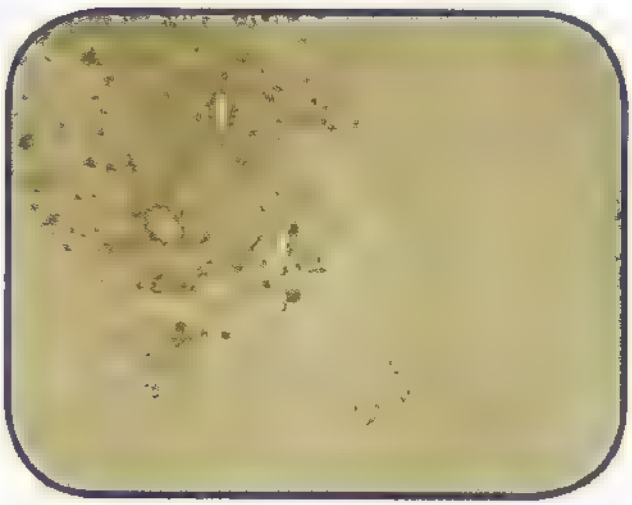
3.26a. Two renal tubular epithelial cells (500x).

3.27a: Two renal tubular epithelial cells (500x).



3.28a: Two renal tubular epithelial cells (400x).

3.29a Cuboidal form of renal tubular epithelial cells (400x).



3.30a: Clumped renal tubular epithelial cells. Notice three cells at the bottom (400x).

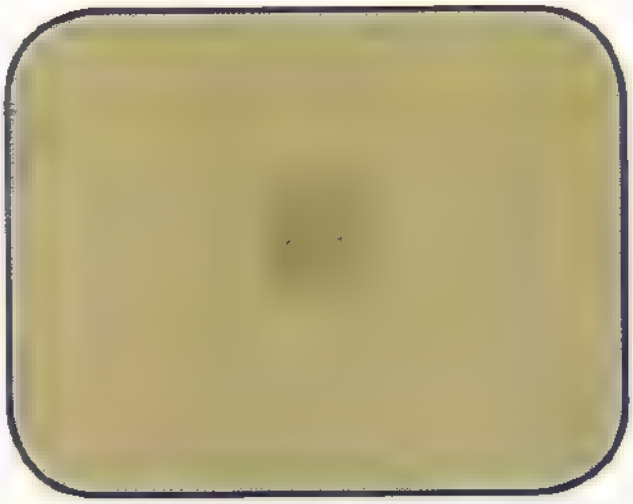


Fig. 3.31a: Oval fat body (400x).

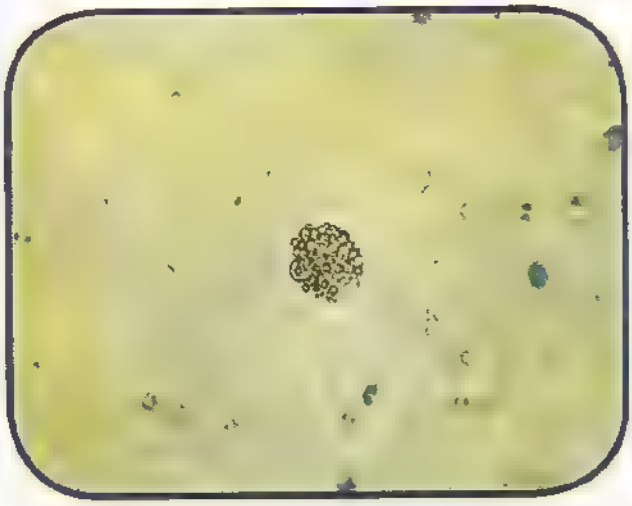


Fig. 3.32a: Oval fat body (400x).

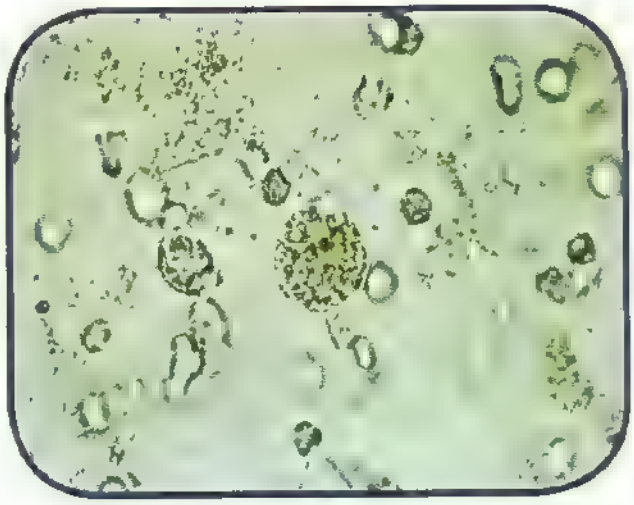


Fig. 3.33a: Oval fat bodies (400x).

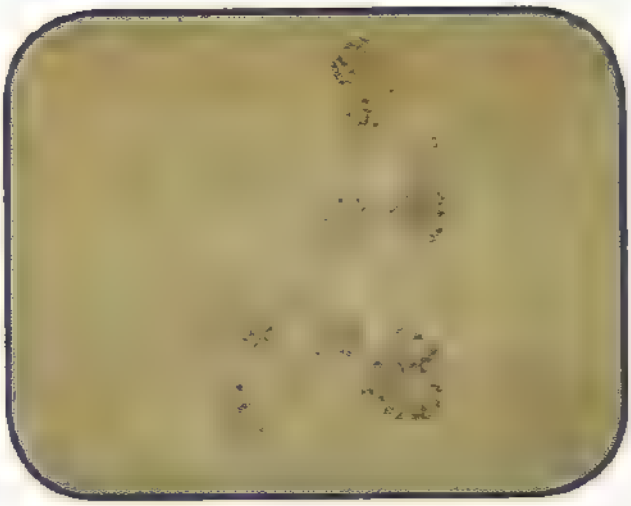


Fig. 3.34a: Oval fat bodies (400x).

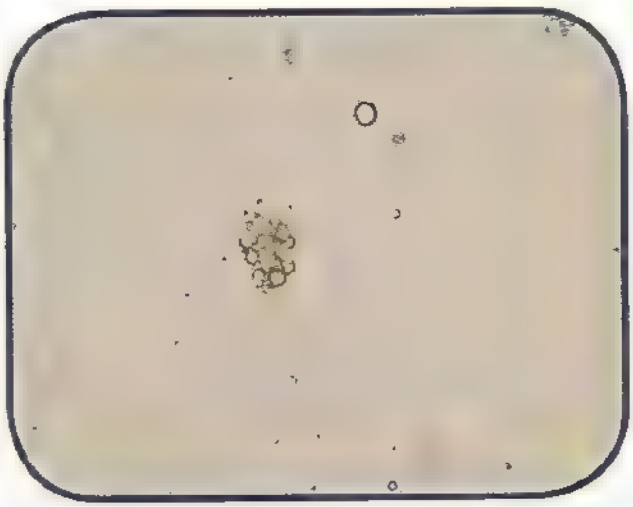


Fig. 3.35a: Oval fat bodies (400x).

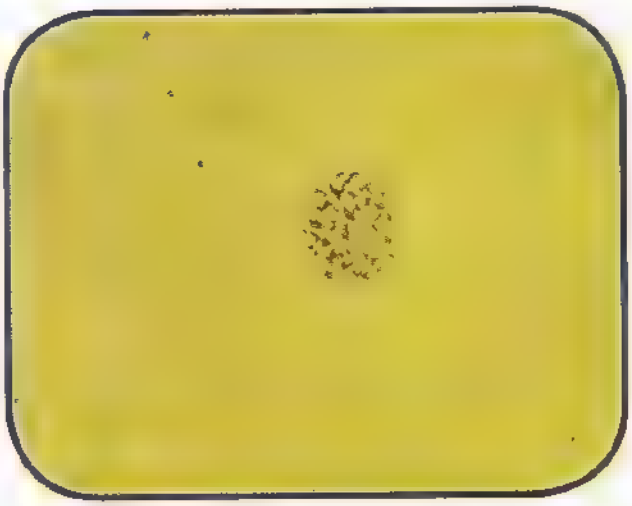


Fig. 3.36a: Oval fat body (400x).

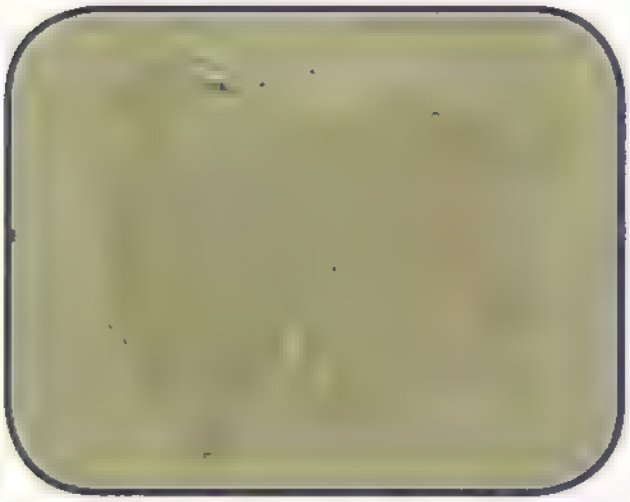


Fig: 3.37a: Clue cells (400x).

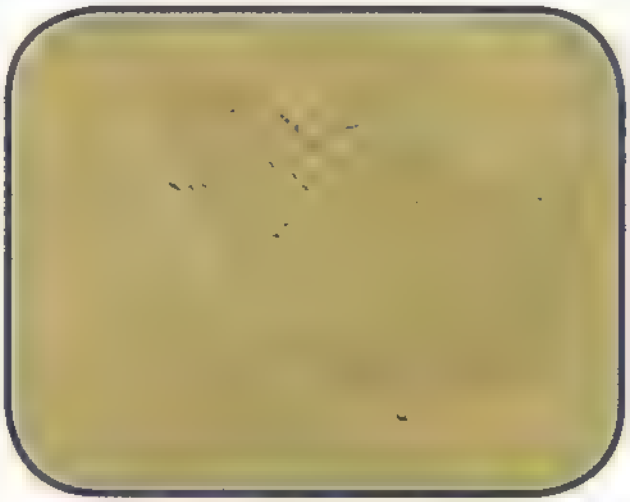


Fig: 3.38a: Clue cells and squamous epithelial cells (400x).

Fig: 3.39a: Clue cells (400x).

Fig: 3.40a: Clue cells (400x).

Fig: 3.41a: Clue cells (400x).

Fig: 3. 42a: Clue cells (400x).

Casts

Casts are the only elements found in the urine sediments that are unique to the kidney. The casts are classified by a substance incorporated into the cast matrix as follows:

Non cellular casts

1) Hyaline casts

- Hyaline casts are low refractive index and translucent, color less empty homogeneous matrix makes this cast very hard to see using bright field microscopy.
- Normal: 0-2 hyaline casts/LPF.
- Hyaline cast may misdiagnosed with mucus, fibers and hairs.

2) Granular casts

- Granular casts contain irregular sized granules originating from degenerate cells and protein.
- Coarsely and finely granular casts are frequently seen in the urine sediment and may be of pathologic or non -pathologic significance.
- It is not considered necessary to distinguish between coarsely and finely granular casts.
- They may be misdiagnosed with clumps of small crystals and columnar RTE cells.

3) Waxy casts

- Waxy casts are hyaline casts that have remained in the kidney tubules a long time.
- Highly refractile, homogeneous texture, well defined edges and blunt uneven ends.
- There are cracks along the length of the cast and may appear yellow to gray to colorless.
- They may be misdiagnosed with fibers and fecal material.

4) Fatty casts

- Fatty casts are seen in conjunction with oval fat bodies and free fat droplets in disorders causing lipiduria.
- They are highly retractile due to fat contents and the fat in the form of free fat droplets or oval fat bodies .
- Fatty cast may be misdiagnosed with fecal debris .

Cellular casts

1) Red blood cell casts

- Red blood cell (RBC) casts are red blood cells inside a hyaline cast.
- They may appear yellow to reddish-brown color due to degenerating or hemolyzing RBCs.

- RBC cast may be misdiagnosed with clumped RBCs.

2) White blood cell casts

- White blood cell (WBC) casts are white blood cells inside a hyaline cast.
- WBC casts are composed of neutrophils; therefore, they may appear granular and multilobed nuclei will be present.
- They identify by looking for lobed nucleus.
- WBC cast may be misdiagnosed with clumped WBCs or renal tubular epithelial cast.

3) Renal tubular epithelial cell casts

- Renal tubular epithelial cell casts are renal tubular epithelial cells in hyaline matrix.
- These casts containing RTE cells represent the presence of advanced tubular destruction, producing urinary stasis along with disruption of the tubular linings.
- Epithelial cast may be misdiagnosed with WBC cast or clumped renal epithelial cells.

Other casts

There are other casts may be cellular, non-cellular or mixed casts such as: broad, bacteria, pigmented, crystals and mixed casts.

Broad casts: The broad casts like waxy casts represent extreme urine stasis. However, all types of casts may occur in the broad form.

Bacterial casts: Bacterial casts containing bacilli both within and bound to the protein matrix are seen in pyelonephritis. They may be pure bacterial casts or mixed with WBCs.

Pigmented casts: The pigmented casts most commonly found are erythrocytic origin (Haemoglobin). Pigmentation may also be observed when chromogenic drugs have been administrated and also in cases of jaundice (Bilirubin).

Crystal cast: Cast containing urates, calcium oxalate and sulfonamides are occasionally seen.

Mixed casts: The presence of mixed elements in a cast may make identification more difficult. The mixed cellular cast most frequently encountered include RBC and WBC casts in glomerulonephritis or WBC and RTE cell casts. Other mixed cast also seen in urine are granular and hyaline cast, hyaline and cellular cast, granular and waxy or cellular and waxy casts.

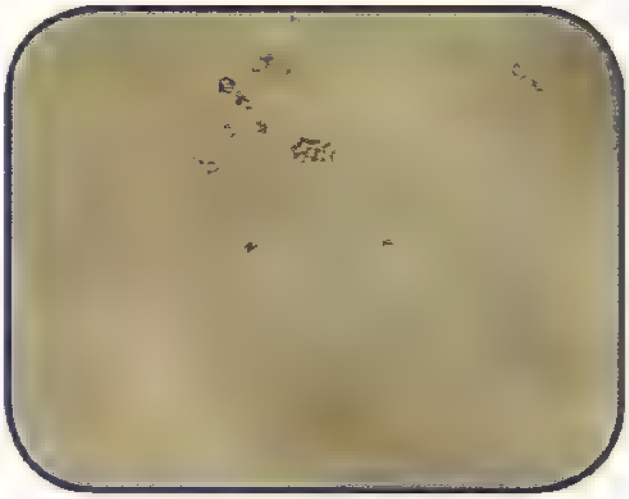


Fig. 3.1b: Hyaline cast (100x).

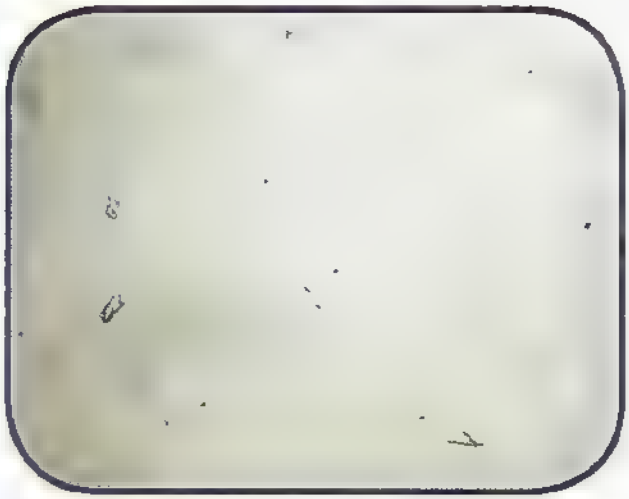


Fig. 3.2b: Hyaline cast (100x).

Fig. 3.3b: Hyaline cast (400x).

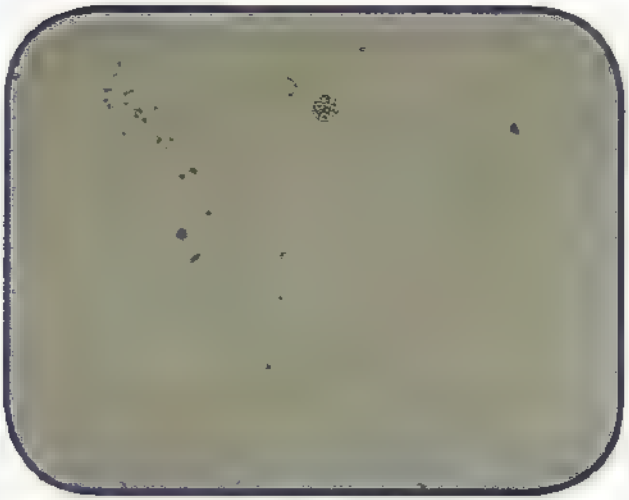


Fig. 3.4b: Hyaline casts and mucus threads (250x).

Fig. 3.5b: Hyaline cast (100x).

Fig. 3.6b: Hyaline casts (100x).

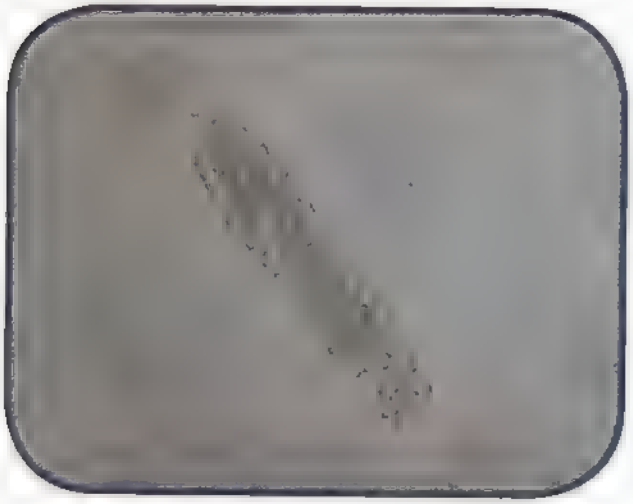


Fig. 3.7b: Finely granular cast (400x).

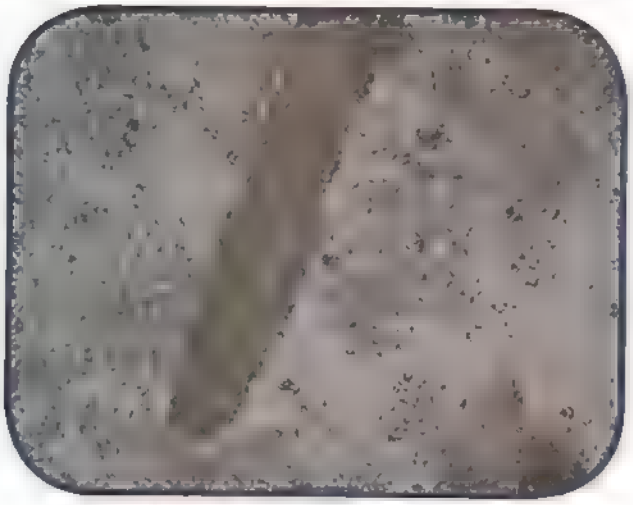


Fig. 3.8b. Coarsely granular cast and amorphous materials (250x).

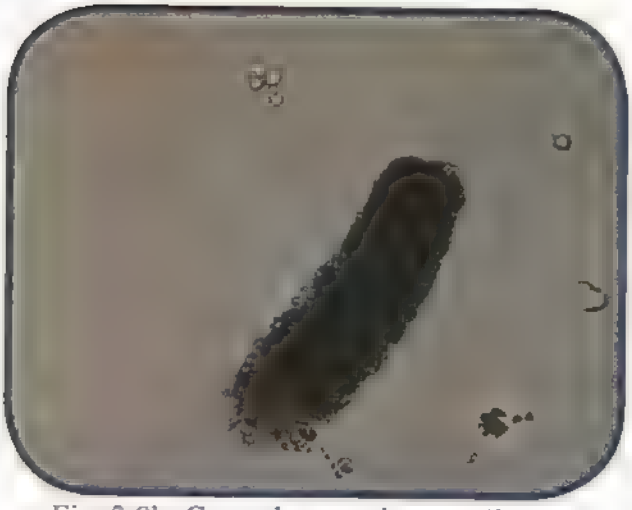


Fig. 3.9b: Coarsely granular cast (250x).

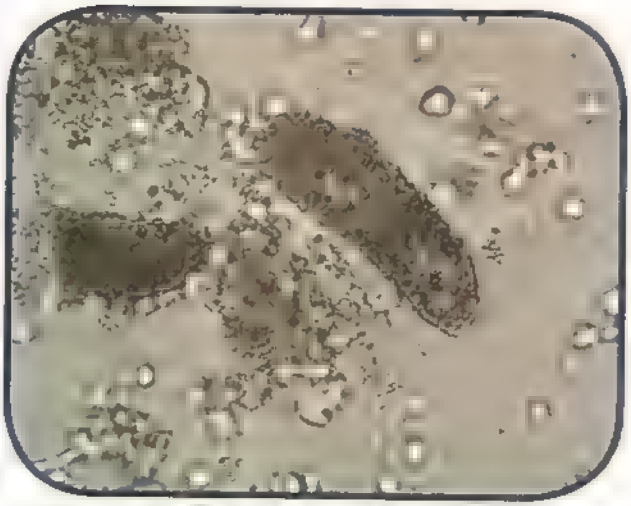


Fig. 3.10b: Coarsely granular casts (400x).

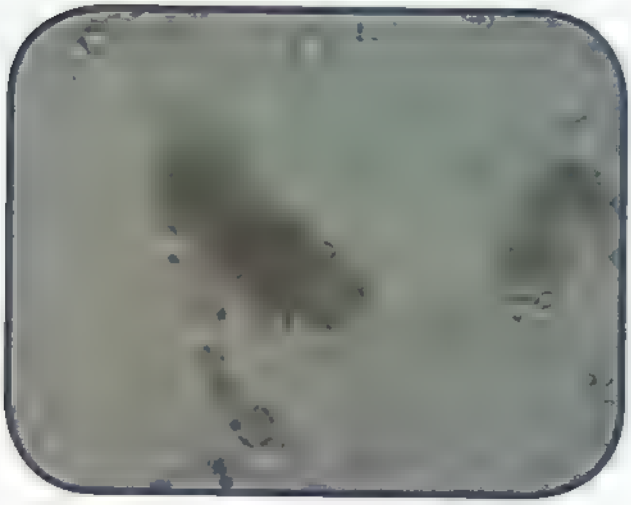


Fig. 3.11b: Coarsely granular casts (250x).

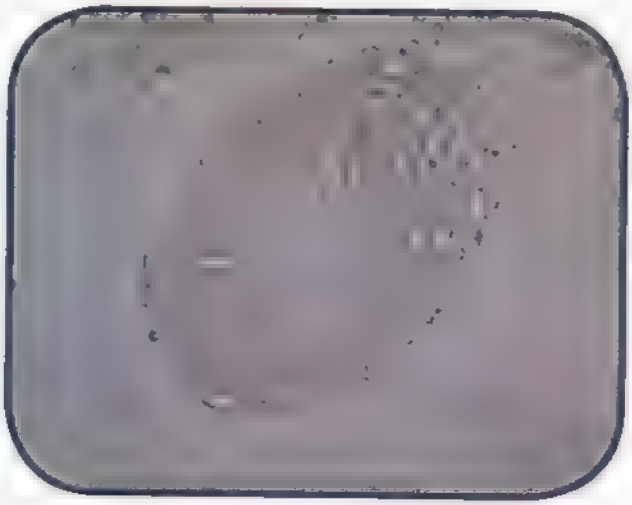


Fig. 3.12b: Coarsely broad granular cast (400x).

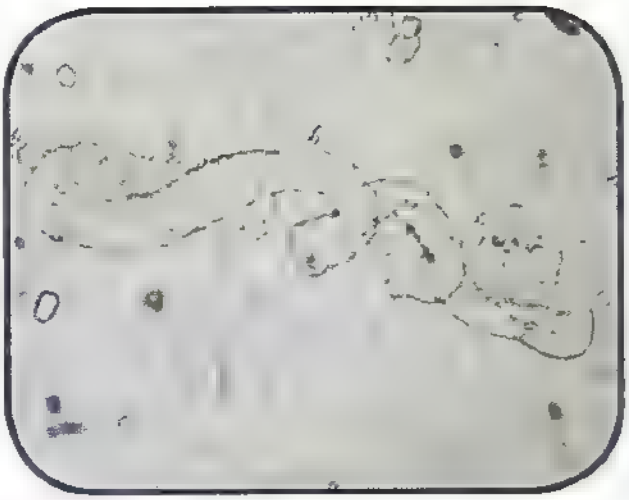


Fig. 3.13b: Convoluted waxy cast (400x).

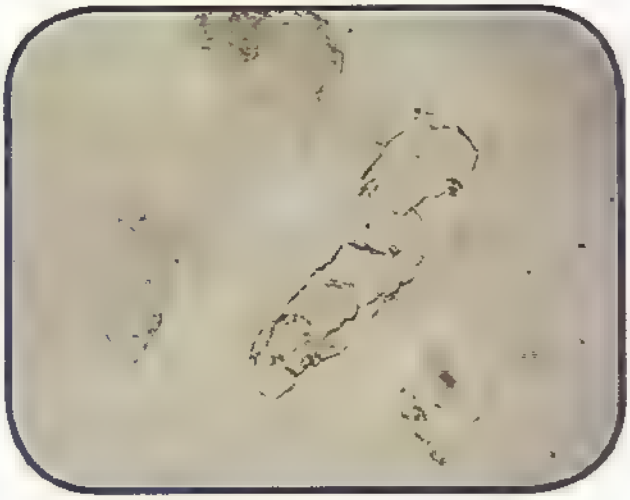


Fig. 3.14b: Waxy casts (400x).

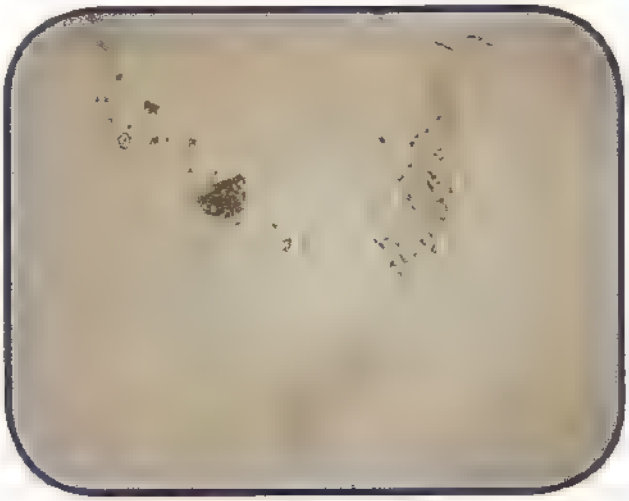


Fig. 3.15b: Waxy casts (250x).

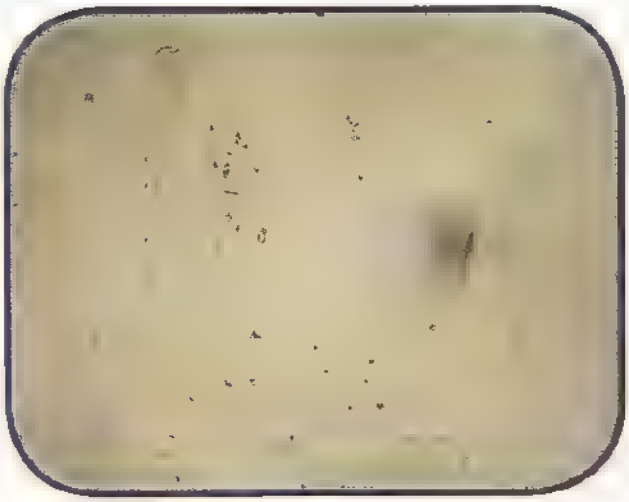


Fig. 3.16b: Large and small waxy casts (160x).

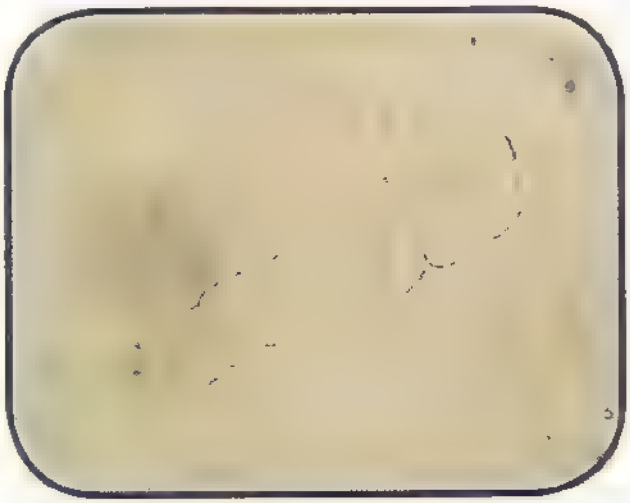


Fig. 3.17b: Waxy casts (250x).

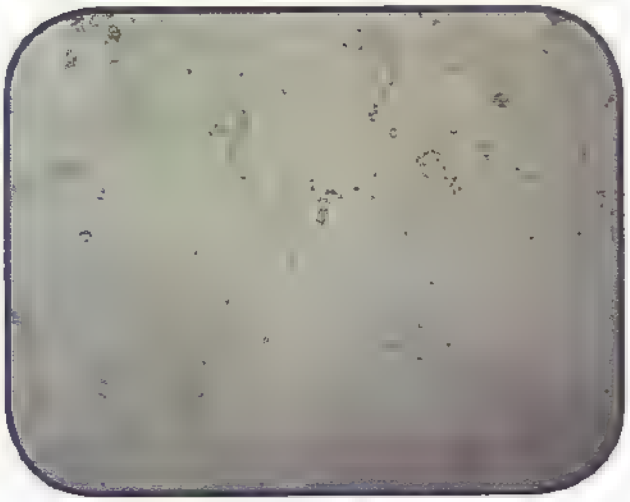


Fig .3.18b: Small waxy casts (160x).

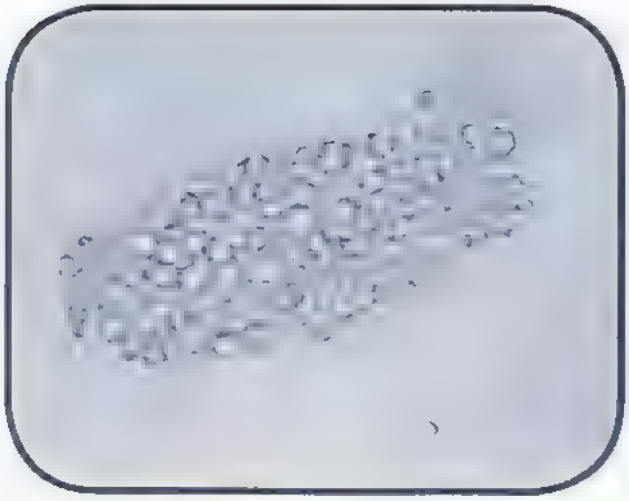


Fig. 3.19b: Fatty cast (400x)

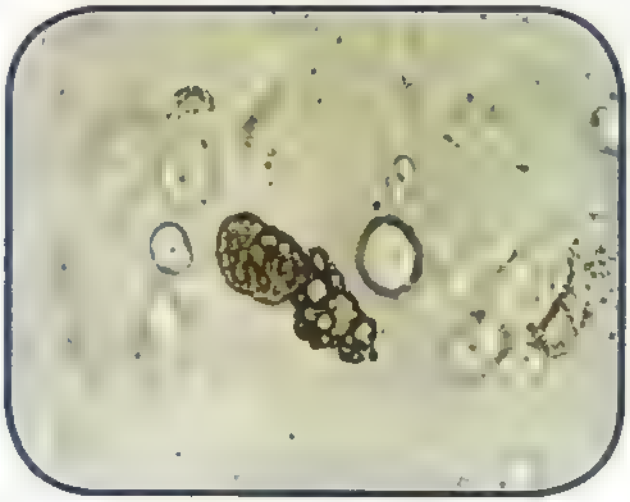


Fig. 3.20b: Fatty cast (400x).

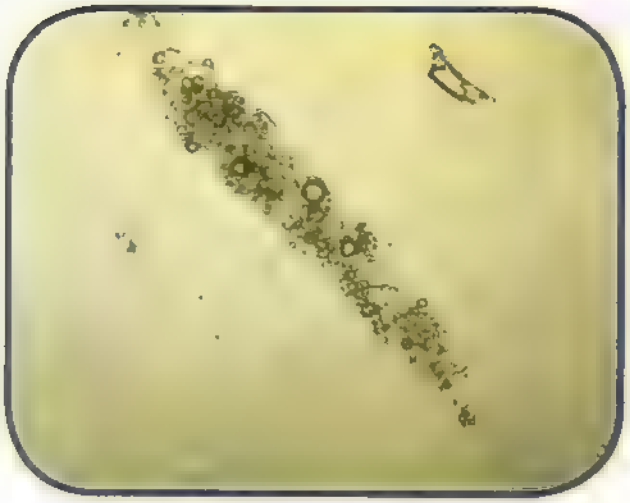


Fig. 3.21b: Fatty cast (160x).

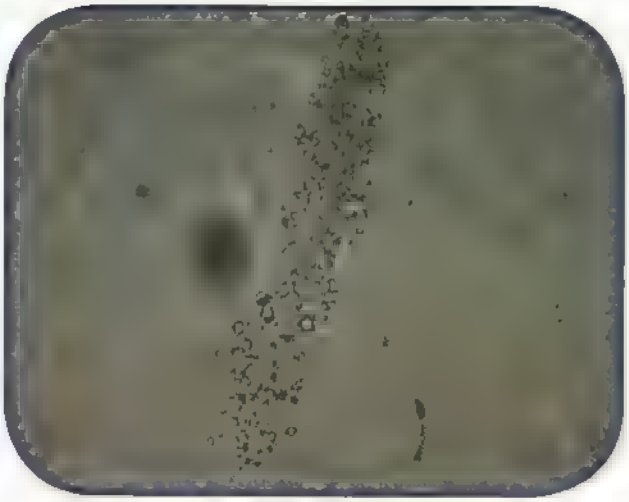


Fig. 3.22b: Fatty cast (400x).

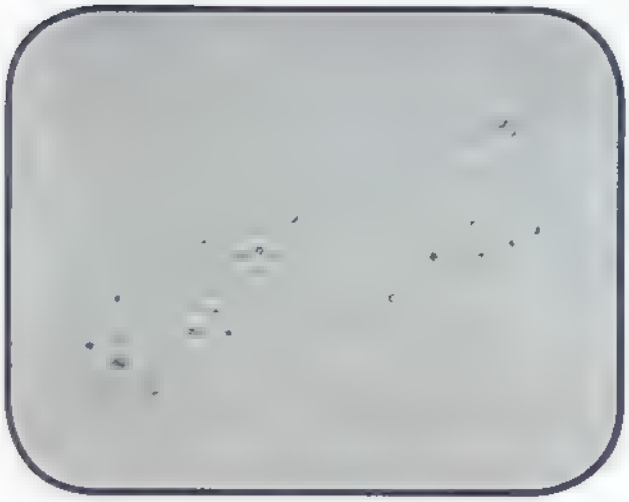


Fig. 3.23b: Fatty cast (400x).

Fig. 3.24b: Fatty cast (400x).

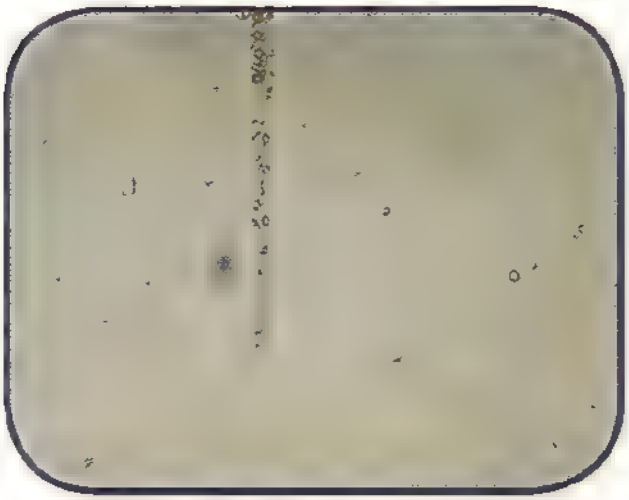


Fig. 3.25b: Red blood cell cast (160x).

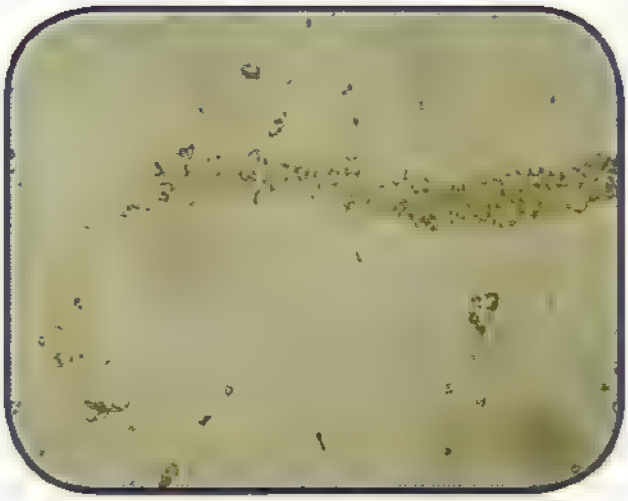


Fig. 3.26b: Red blood cell cast (250x).

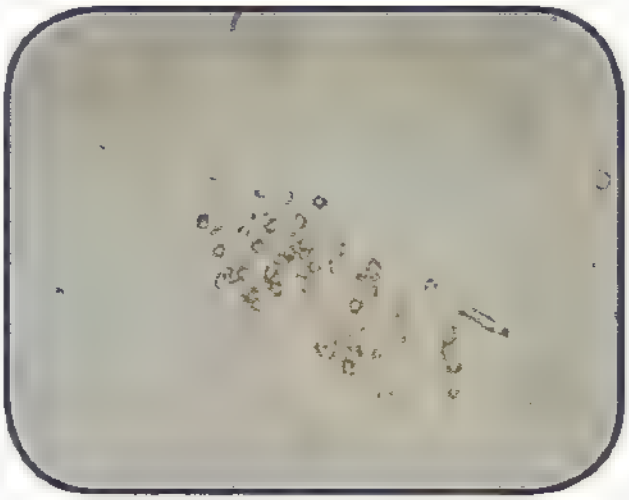


Fig. 3.27b: Red blood cell cast and red blood cells (400x).

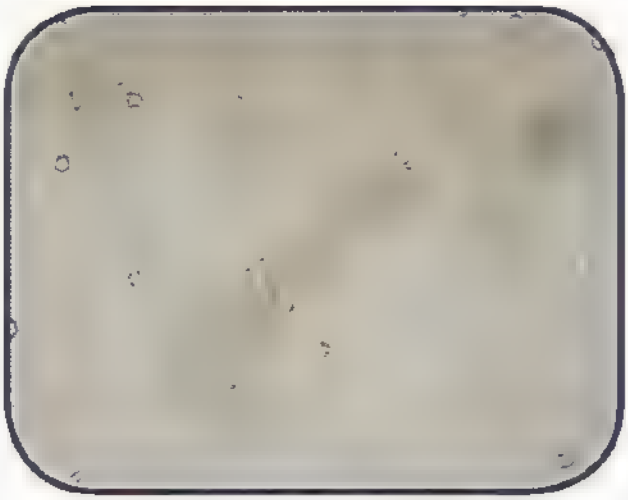
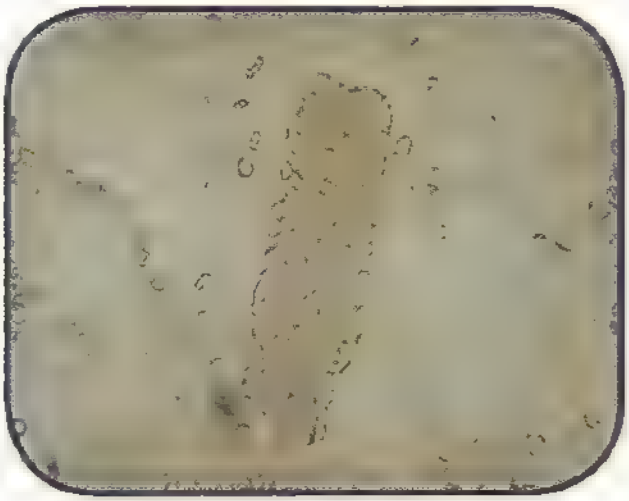


Fig. 3.28b Red blood cells cast and red blood cells (250x).



3.29b: Red blood cells cast and red blood cells (250x).

Fig. 3.30b: Red blood cell cast (250x).

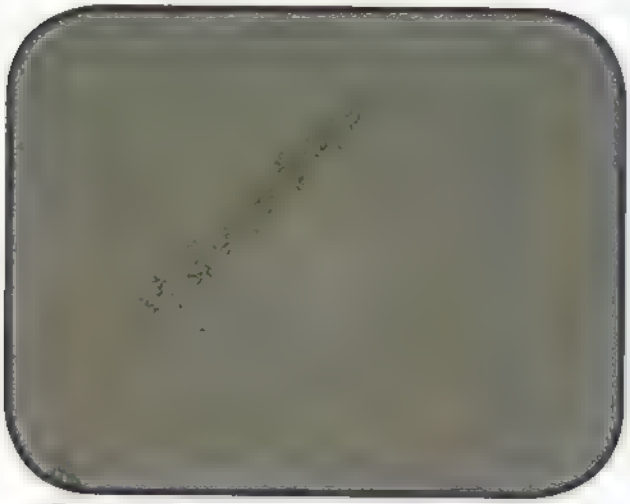


Fig. 3.31b White blood cell cast (400x).

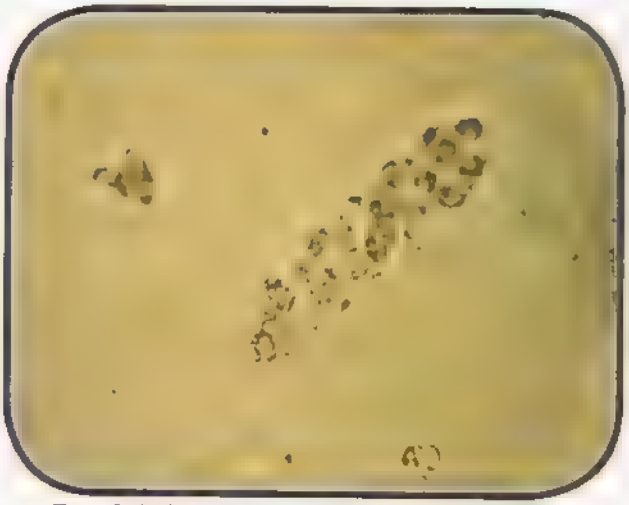


Fig. 3.32b White blood cell cast (400x).

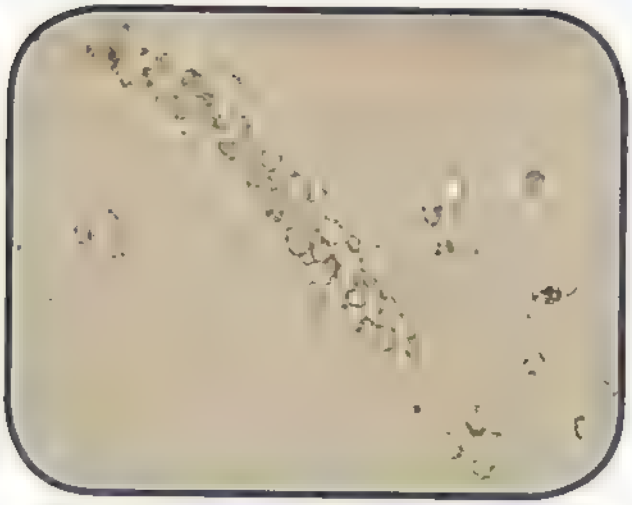


Fig. 3.33b White blood cell cast (400x).

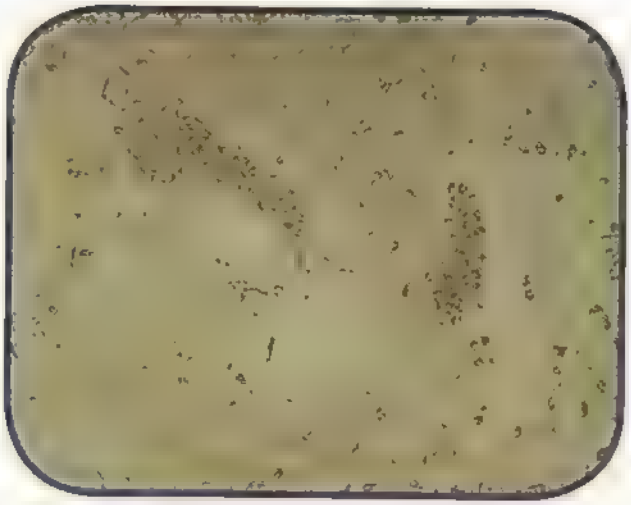


Fig. 3.34b Two White blood cell casts and epithelial cells (250x).

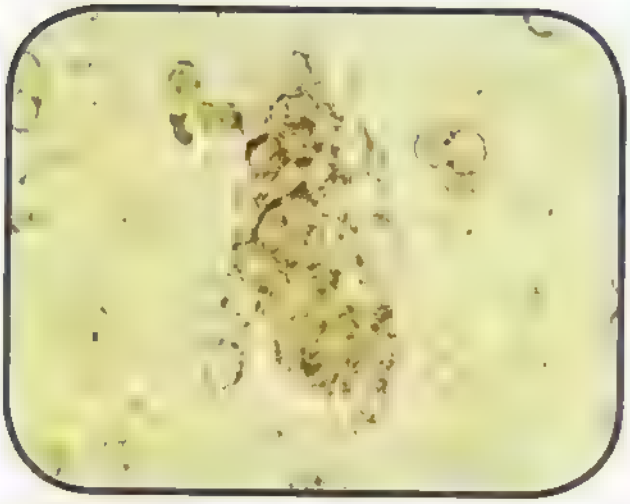


Fig. 3.35b White blood cell cast and White blood cells (500x).

Fig. 3.36b White blood cell cast (250x).

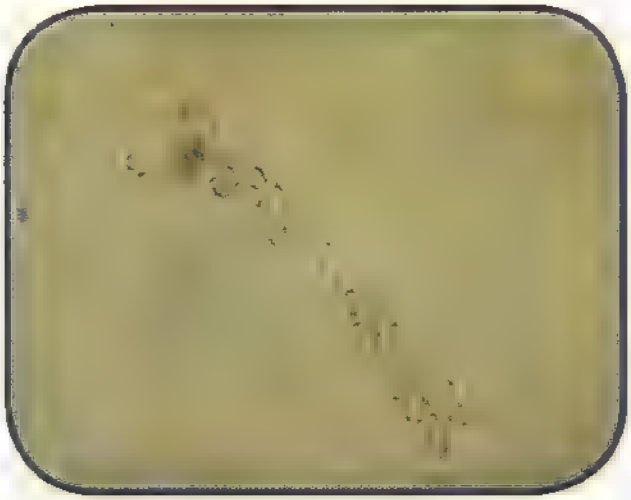


Fig 3 37b: Renal tubular epithelial cell cast (400x).

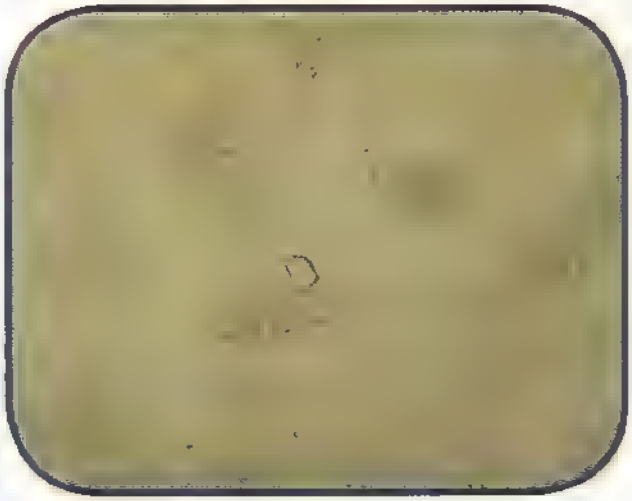


Fig 3.38b Renal tubular epithelial cell cast (400x).

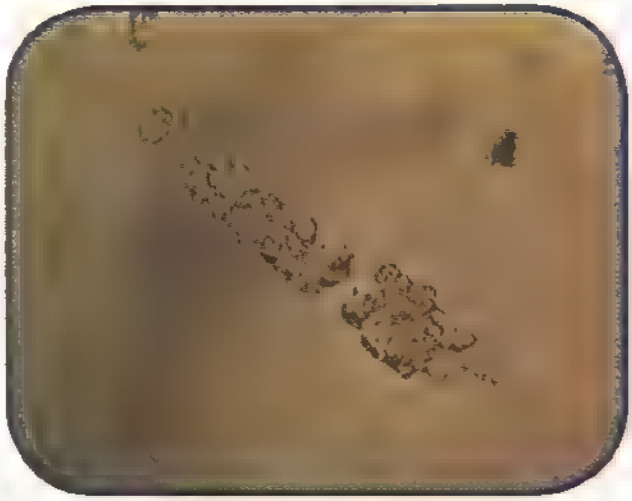


Fig. 3 39b: Renal tubular epithelial cell cast (400x).

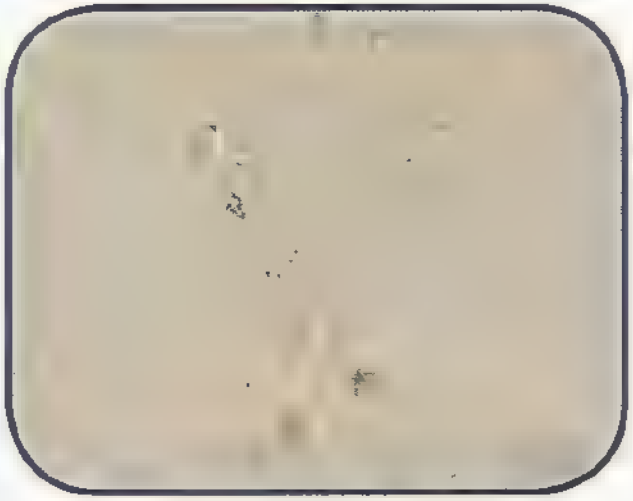


Fig. 3.40b: Renal tubular epithelial cell cast (400x).

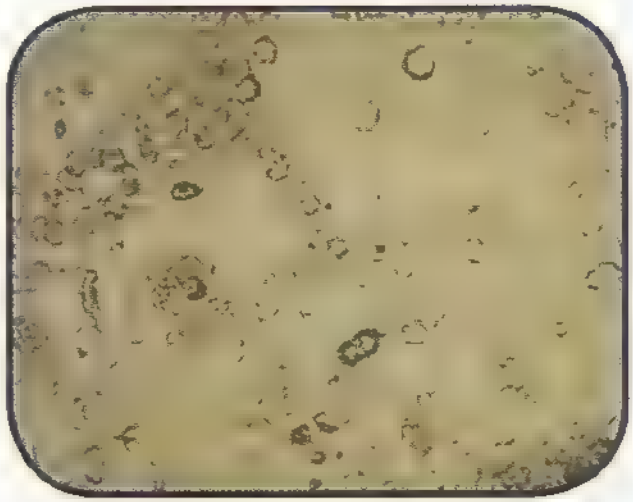


Fig 3 41b: Renal tubular epithelial cell cast and epithelial cells (400x).

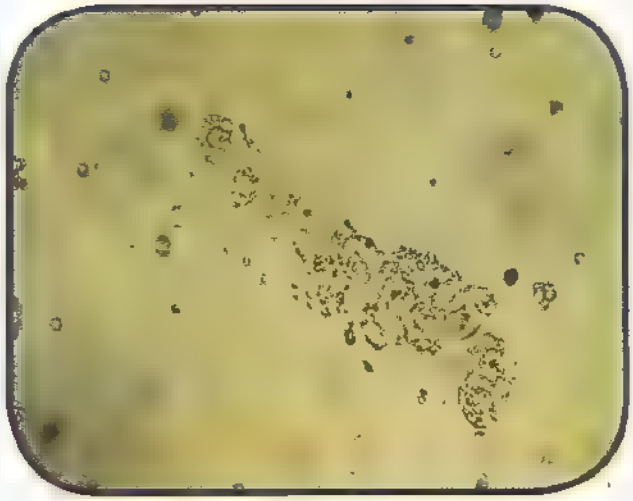


Fig. 3.42b. Renal tubular epithelial cell cast (400x).

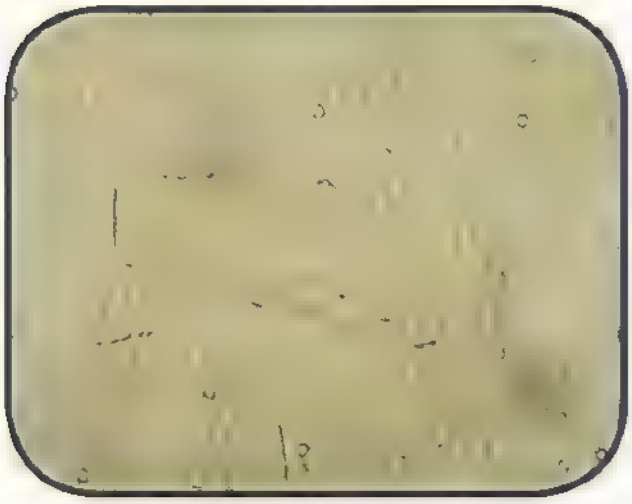


Fig. 3.43b: Broad waxy cast (400x).

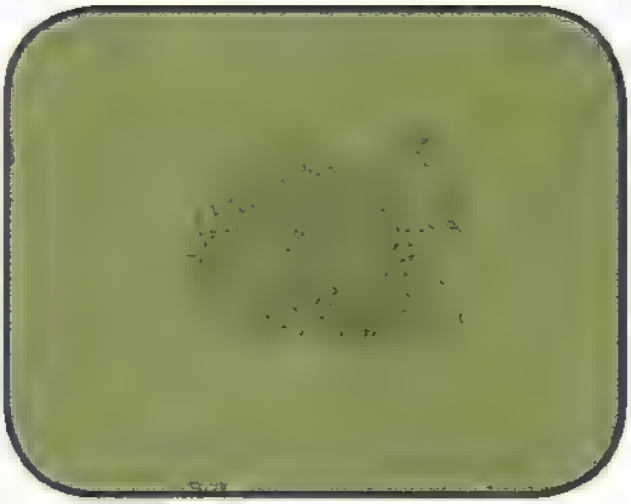


Fig. 3.44b: Bacterial cast (400x).

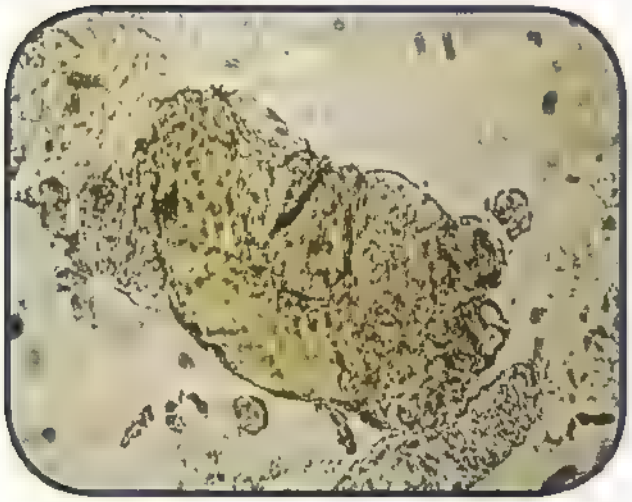


Fig. 3.45b: Pigmented Waxy cast (400x).

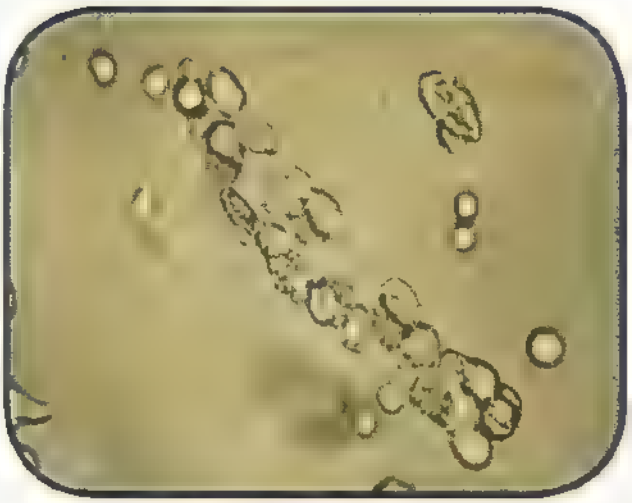


Fig. 3.46b: Cellular cast (400x)

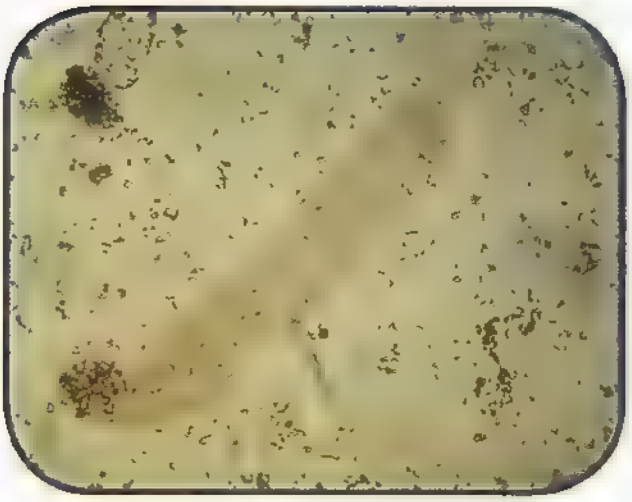


Fig. 3.47b: Granular waxy cast (400x).

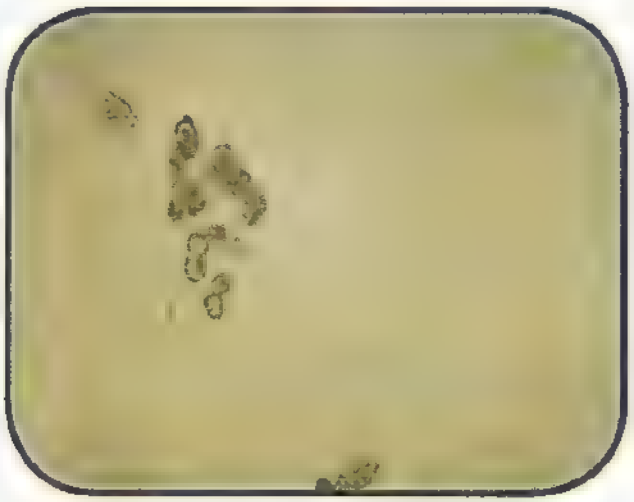


Fig. 3.48b: Hyaline cast with calcium oxalate inclusions (400x).

Crystals

Crystals are usually not found in freshly voided urine, but appear after the urine stands for a while. The appearance of urine crystals are classified according to the pH of urine into:

Crystals in acid urine

1) Uric acid crystals

- Uric acid crystals are seen in a variety of shapes, including rhombic, four-sided flat plates (whetstones), wedges, rosettes, prism, oval forms with pointed end (lemon shaped) or irregular plates.
- Uric acid crystals are also seen as hexagonal, sheaves, dumbbell form, hourglass, rod like crystals, large crosses, sunflower forms, drusy form, flaske like, spindle like or comb forms.
- They are soluble in alkali but insoluble in alcohol, hydrochloric acid (HCl) and acetic acid.
- Uric acid crystals may be misdiagnosed with cystine crystals .

2) Cystine crystals

- Cystine crystals appear as colorless, hexagonal plates and may be thick or thin.
- They are soluble in HCl and alkali, especially ammonia, but insoluble in acetic acid, alcohol, acetone, ether, and boiling water.
- Cystine crystals may be misdiagnosed with uric acid crystals.

3) Amorphous urates

- Amorphous urate have no distinct form and appear as sand-like or moss like granules.
- These appear as brick dust and yellow brown granules.
- They are soluble in alkali and 60 °C but insoluble in acetic acid.
- Amorphous urates may be misdiagnosed with amorphous phosphate and can be differentiated in pH.

4) Sodium urate crystals

- Sodium urate crystals frequently seen in conjunction with amorphous urates and have little clinical significance.
- They are needle-shaped and are seen in synovial fluid during episodes of gout, but do appear in the urine.
- These crystals are also have fan-shaped and may be yellow in color.
- They are soluble in 60°C and slightly soluble in acetic acid.
- Sodium urate crystals may be misdiagnosed with sulfonamide and Ca sulfate crystals.

5) Bilirubin crystals

- Bilirubin crystals appear as clumped needles or granules with the characteristic yellow color.
- They are soluble in acetic acid, HCl, NaOH, ether and chloroform.
- Bilirubin crystals may be misdiagnosed with radiographic dye crystals and tyrosine.

6) Cholesterol crystals

- Cholesterol crystals are rarely seen unless specimens have been refrigerated, because the lipids remain in droplet form and at times, cholesterol crystals are found as a film on the surface of the urine instead of in the sediment.
- They are colorless transparent rectangular plates with a notch in one or more corners.
- They are soluble in chloroform, ether and hot alcohol.
- Cholesterol crystals may be misdiagnosed with radiographic dye crystals.

7) Calcium sulfate crystals

- Calcium sulfate crystals are long, thin, colorless needles or prisms that are identical in appearance to calcium phosphate.
- The pH of the urine helps to differentiate these two crystals, because calcium sulfate is found in acidic urine, whereas calcium phosphate is usually found in alkaline urine.
- They are soluble in acetic acid.
- Calcium sulfate crystals may be misdiagnosed with sodium urate, Ca phosphate and Sulfonamides.

Crystals in acid and neutral urine

1) Tyrosine crystals

- Tyrosine crystals appear as fine colorless to yellow needles that frequently form clumps or rosettes.
- They are soluble in ammonium hydroxide and HCl but insoluble in acetic acid.
- Tyrosine crystals may be misdiagnosed with bilirubin crystals.

2) Leucine crystals

- Leucine crystals are yellow-brown spheres that demonstrate concentric circles and radial striations.
- They are seen less frequently than tyrosine crystals and, when present, should be accompanied by tyrosine crystals.
- They are soluble in hot acetic acid, hot alcohol and in alkali but insoluble in HCl.
- Leucine crystals may be misdiagnosed with large fat globules.

Crystals in acid, neutral and alkaline urine

1) Hippuric acid crystals

- Hippuric acid crystals are yellow brown or colorless elongated prisms or plates or needles.
- They are soluble in water and ether.
- Hippuric acid crystals may be misdiagnosed with calcium oxalate monohydrate.

2) Calcium oxalate crystals

- Calcium oxalate crystals have various shapes and may be found in two forms dihydrate and monohydrate.
- The most common form of calcium oxalate crystals is the dihydrate that is easily recognized as a colorless, octahedral envelope or as two pyramids joined at their bases.
- Monohydrate calcium oxalate crystals are oval or biconcave disks which have a dumbbell shaped.
- Calcium oxalate crystals are sometimes seen in clumps attached to mucous strands and may resemble casts.
- They are soluble in HCl but insoluble in acetic acid.
- Calcium oxalate crystals (monohydrate) may be misdiagnosed with RBC, yeast cell and hippuric acid crystals and (dihydrate) may be misdiagnosed with triple phosphate.

Crystals in neutral and alkaline urine

1) Amorphous phosphates

- Amorphous phosphates are granular in appearance, similar to amorphous urates.
- These crystals have no distinct form and appear as sand-like granules.
- They are soluble in dilute acetic acid.
- Amorphous phosphates may be misdiagnosed with amorphous urates and Ca carbonate crystals.

2) Calcium phosphate and dicalcium phosphate crystals

- Calcium phosphate crystals form large, thin, irregular plates that may float on the surface of the urine.
- Dialcium phosphate crystals are long, thin, colorless prisms and can have one pointed end and may be arranged as rosettes or stars (stellar phosphates).
- They are soluble in dilute acetic acid.
- Dicalcium phosphate crystals may be misdiagnosed with sulfonamide, sodium urate and Ca sulfate crystals wherease calcium phosphate may be misdiagnosed with clumped mass of calcium carbonate crystals.

Crystals in alkaline urine

1) Triple phosphate crystals

- Triple phosphate (Magnesium ammonium phosphate) crystals are colorless 4-6 sided prisms that frequently resemble a "coffin lid".
- They may sometimes precipitate as feathery or fernlike crystals.
- They are soluble in dilute acetic acid.
- Triple phosphate crystals may be misdiagnosed with calcium oxalate and sulfonamide crystals.

2) Ammonium biurate crystals

- Ammonium biurate (Ammonium urate) crystals exhibit the characteristic yellow-brown color frequently described as "thorny apples".
- They are soluble in 60 °C and acetic acid, when soluble in acetic acid they form colorless uric acid crystals.

3) Calcium carbonate crystals

- Calcium carbonate crystals are small and colorless, with dumbbell or spherical shapes.
- They may occur in clumps that resemble amorphous material, but they can be distinguished by the formation of gas after the addition of acetic acid.
- They are soluble in acetic acid with gas production.
- Calcium carbonate crystals may be misdiagnosed with calcium oxlate, bacteria and amorphous material.

Mixed crystals

When more than one crystals appear in urine sediments are called mixed crystals. The most common crystal is calcium oxalate with any of other crystal because it may be found in any urine pH and also other crystals may be found as mixed crystals.

Drug and radiographic dye crystals

Drug crystals

Sulfa crystals

- The sulfa crystals appear in urine after administration of drugs that contain sulfa such as cotrimoxazole and sulfonamides.
- These crystals may precipitate out as sheaves of needles, usually with eccentric binding, and they may be clear or brown in color..
- Two steps should be followed to confirm the presence of sulfa crystals.
  - First, if possible, contact the nursing station (if the urine is from an inpatient) to

verify that the patient is taking sulfa medication.

- Second, perform the lignin test for sulfonamides.

- They are soluble in acetone.
- Sulfonamide crystals may be seen in acid and neutral urine pH.

Ampicillin crystals

- The ampicillin crystals are long, thin, colorless needles and form coarse sheaves or bundles after refrigeration.
- The ampicillin crystals may be seen in acid and neutral urine pH.

Other drug crystals

- Other drugs crystals may appear in urine due to contamination of sediments by vaginal drugs such as (Canesten) crystals from a pharmaceutical product given intravaginally and also by metronidazole vaginal tablets.

Radiographic dye crystals

- Radiographic dyes crystals are seen after administration of X.ray dyes such as Hypaque and Renografin.
- Both dyes crystallize out as pleomorphic needles that can occur singly or in sheaves.
- These needles may be quite large and often seen brown color in acid urine pH.
- Radiographic dyes may be present in the urine for up to 3 days following injection.
- They are soluble in 10% NaOH.

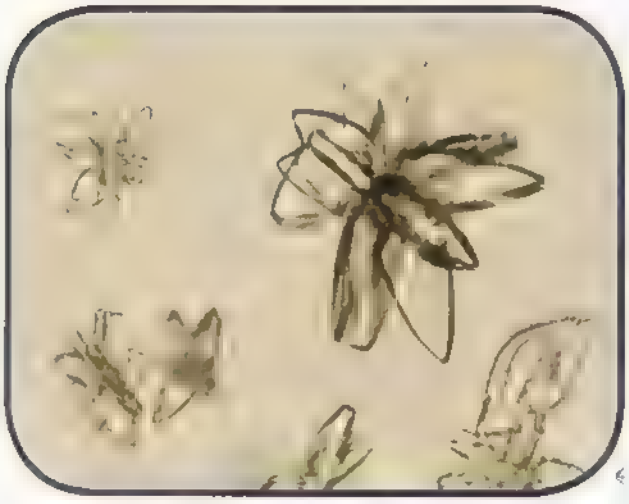


Fig. 3.1c: Rosette shaped of uric acid crystals (400x).

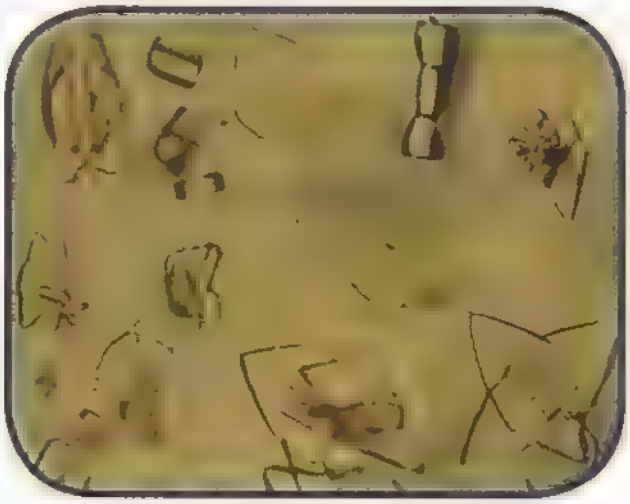


Fig. 3.2c: Various shapes of uric acid crystals. Notice rosette, dumbbell and star shaped (400x).

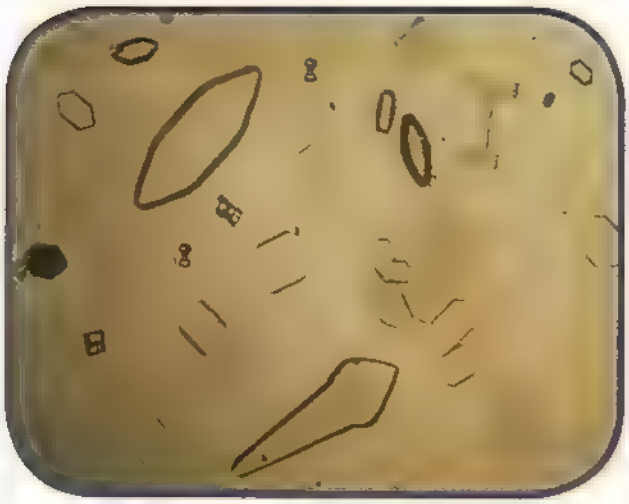


Fig. 3.3c: Various shapes of uric acid crystals Notice spear, six-sided and dumbbell shaped (400x).

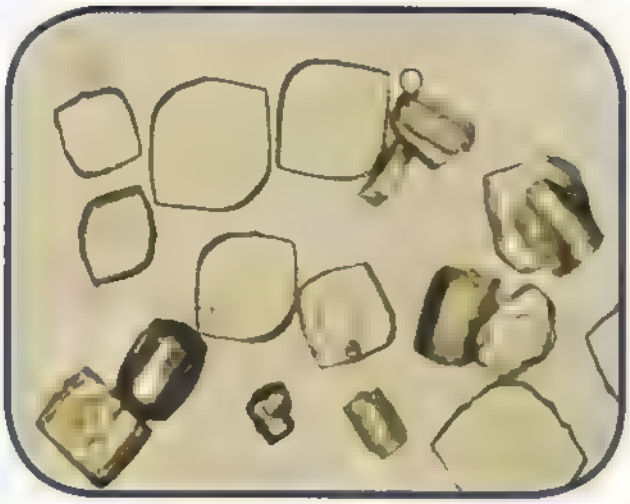


Fig. 3.4c: Uric acid crystals Notice rhombic and barrels shaped (400x).

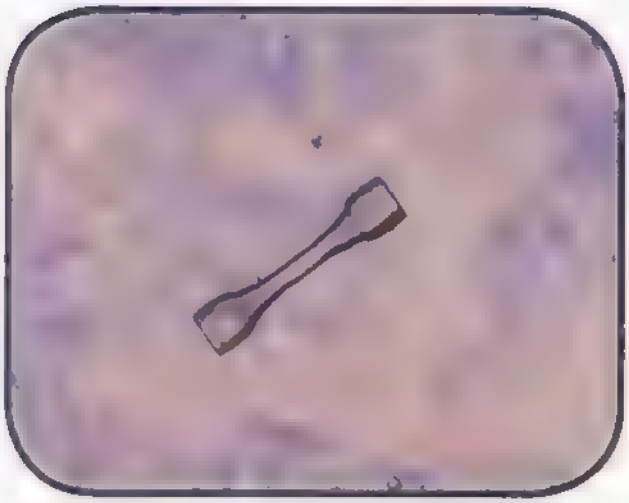


Fig. 3.5c: Uric acid in dumbbell shaped (400x)

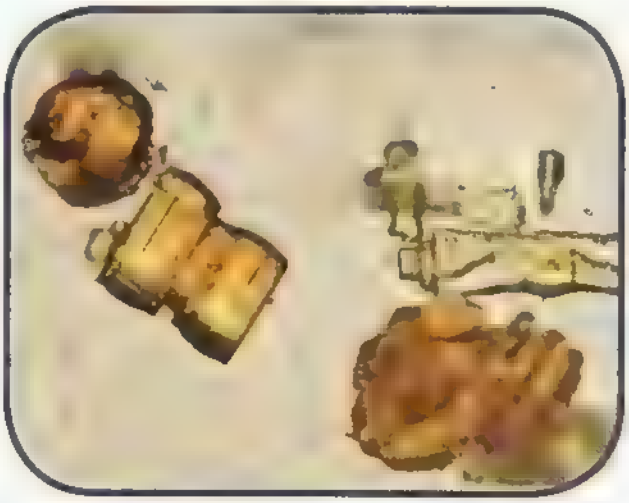


Fig. 3.6c: Unusual shaped of uric acid crystals (400x).

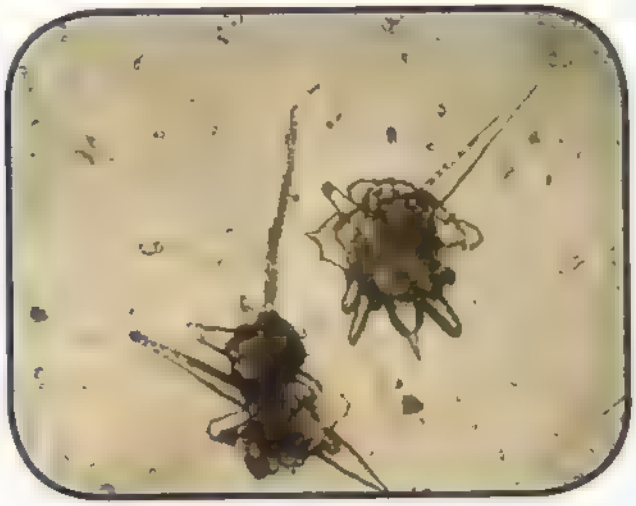


Fig. 3.7c: Uric acid crystals in clusters (400x).

Fig. 3.8c: Cross-shaped uric acid crystals (400x).

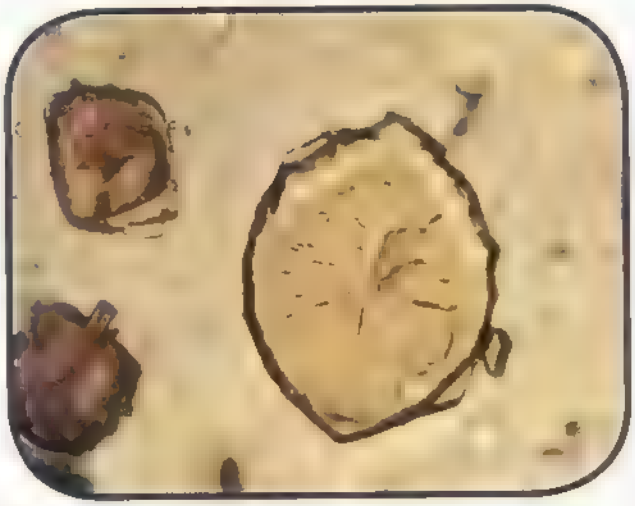


Fig. 3.9c: Polygonal shaped and Unusual clusters of uric acid crystals (400x).

Fig. 3.10c: Uric acid crystals. Notice the olive leaf or lozenge-shaped (400x).

Fig. 3.11c: Uric acid crystals in clusters (400x).

Fig. 3.12c: Various shapes of uric acid crystals (400x).

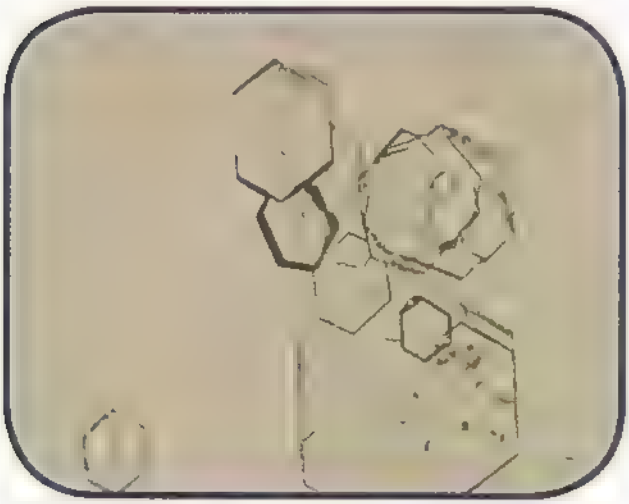


Fig. 3.13c: Cystine crystals in clusters (400x).

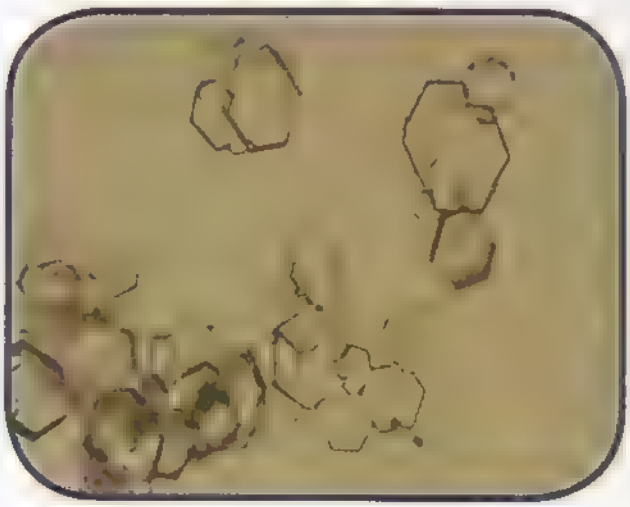


Fig. 3.14c: Cystine crystals (400x).

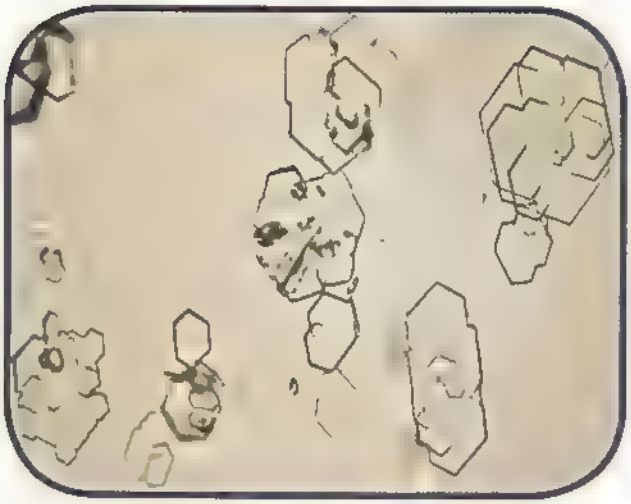


Fig. 3.15c: Cystine crystals in clusters (400x).

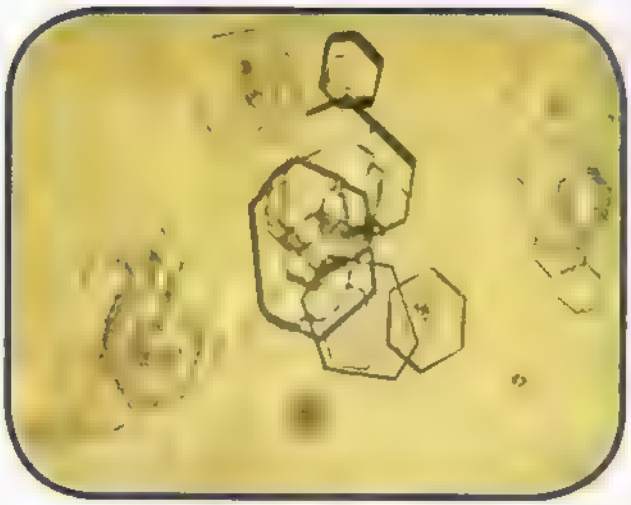


Fig. 3.16c. Cystine crystals in clusters (400x).

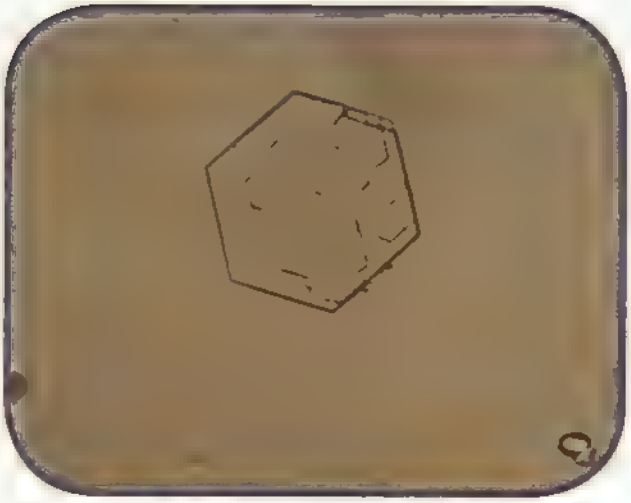


Fig. 3.17c: Cystine crystal (400x).

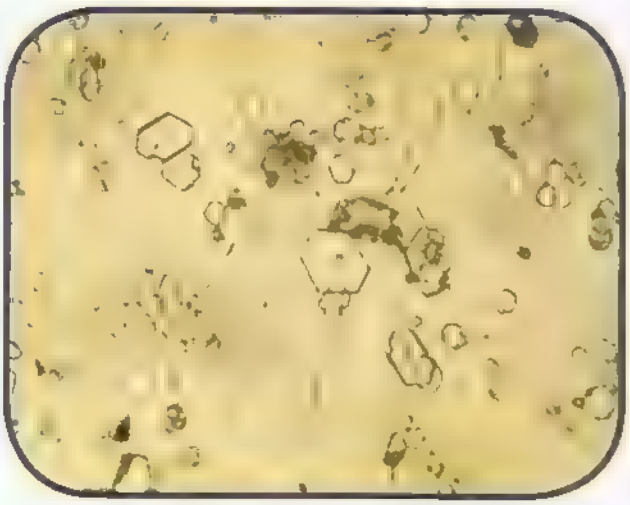


Fig. 3.18c: Cystine crystals (100x).

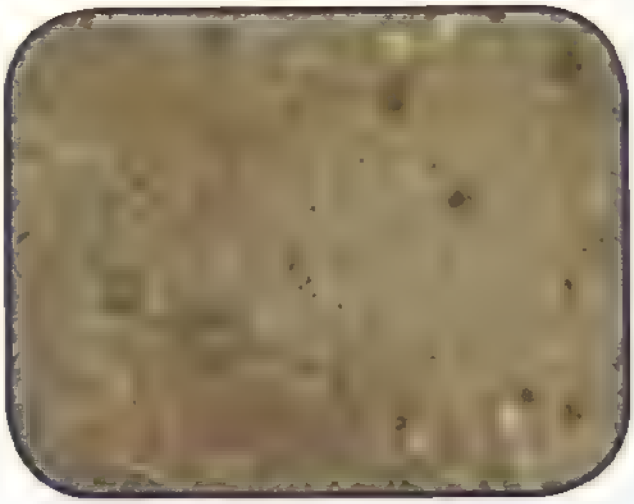


Fig. 3.19c: Amorphous urates and transitional epithelial cells (400x).

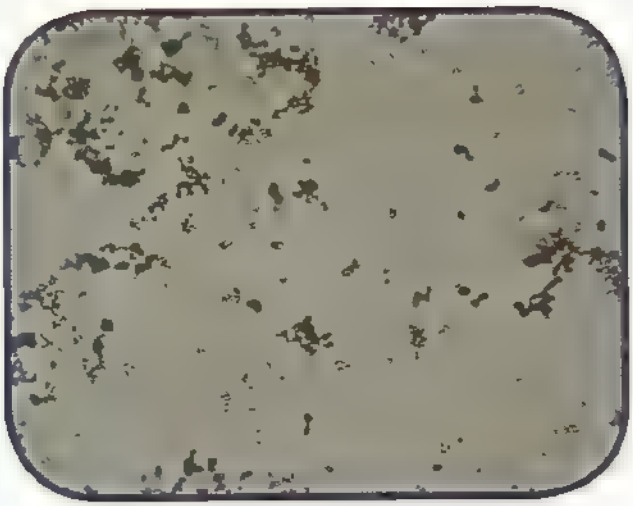


Fig. 3.20c Amorphous urates (100x).

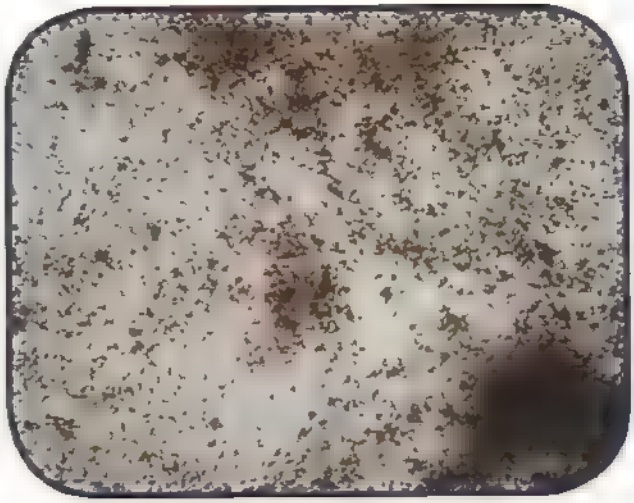


Fig. 3.21c: Amorphous urates (100x).

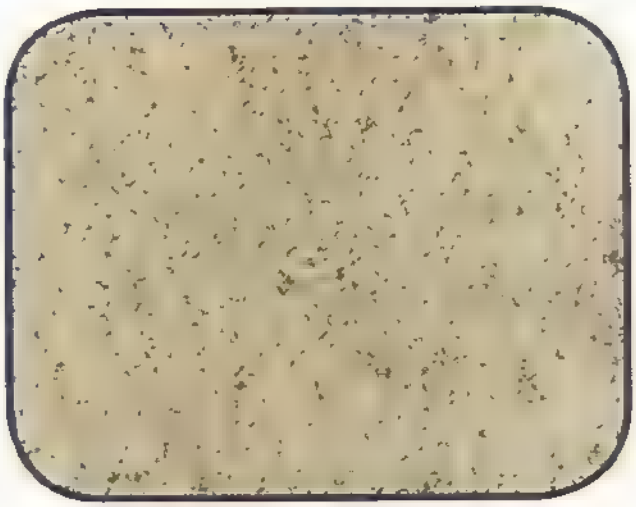


Fig. 3.22c. Amorphous urates (100x).

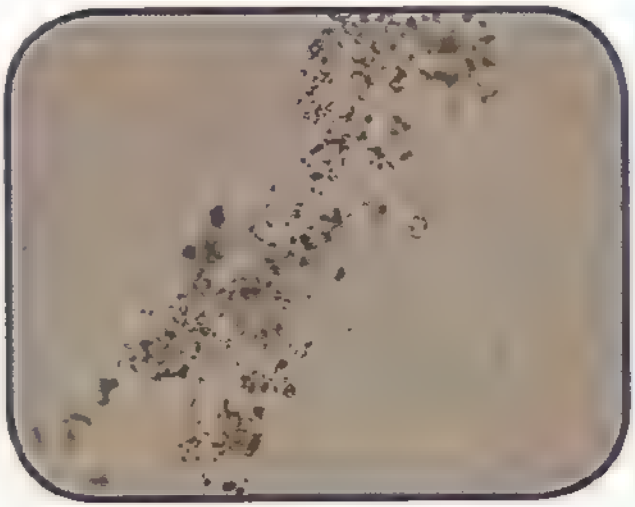


Fig. 3.23c Amorphous urates (100x)

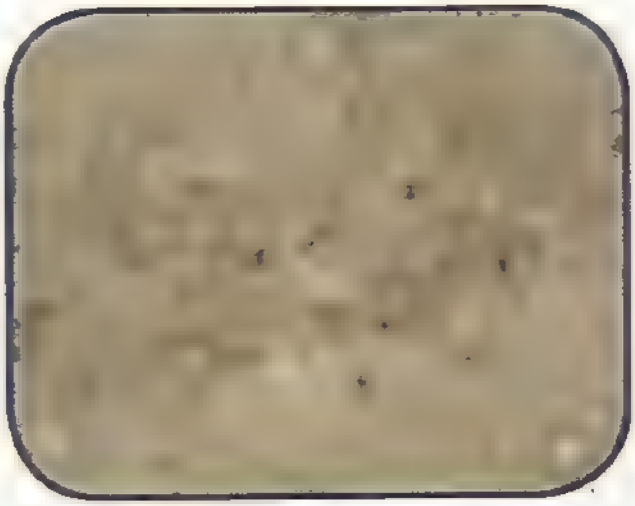


Fig. 3.24c: Amorphous urates (400x).

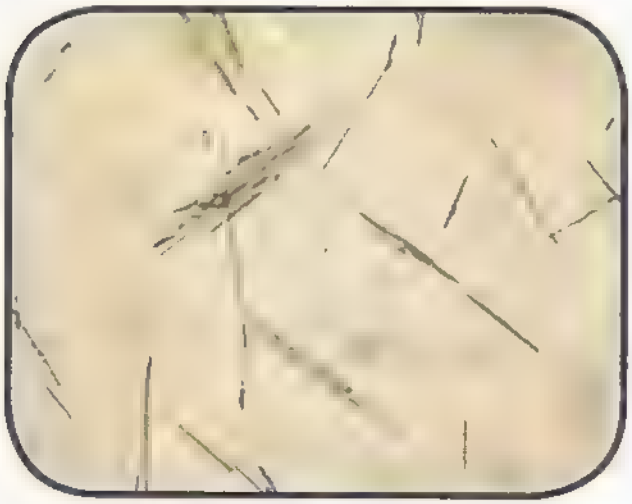


Fig. 3.25c: Sodium urate crystals (100x).

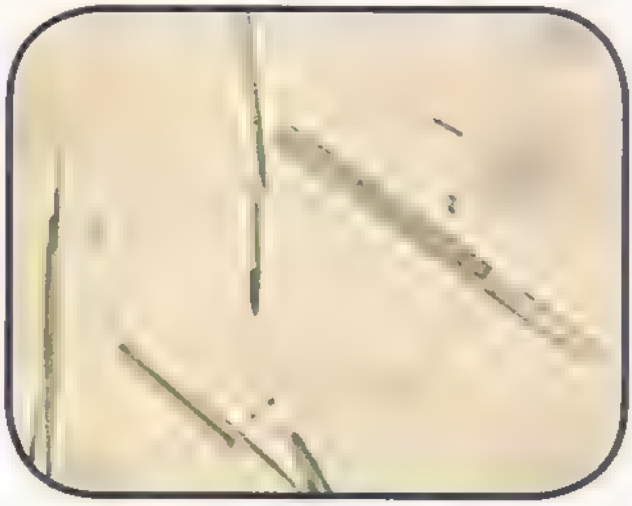


Fig. 3.26c: Same previous field (400x).

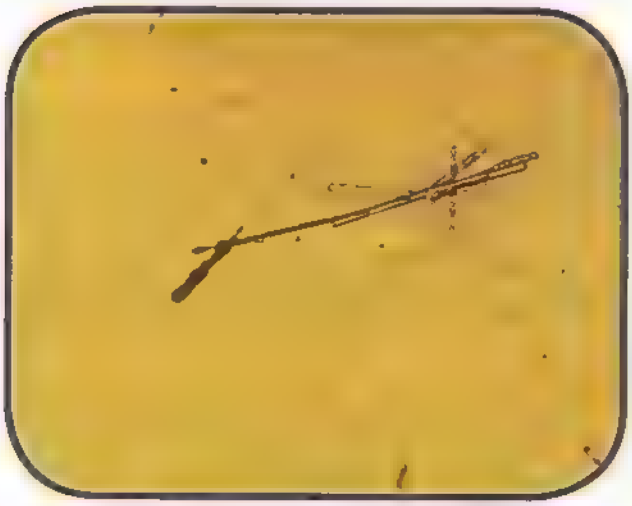


Fig. 3.27c: Sodium urate crystals (400x).

Fig. 3.28c: Sodium urate crystals in clusters (400x).

Fig. 3.29c: Sodium urate crystals (100x)

Fig. 3.30c: Sodium urate crystals (100x).

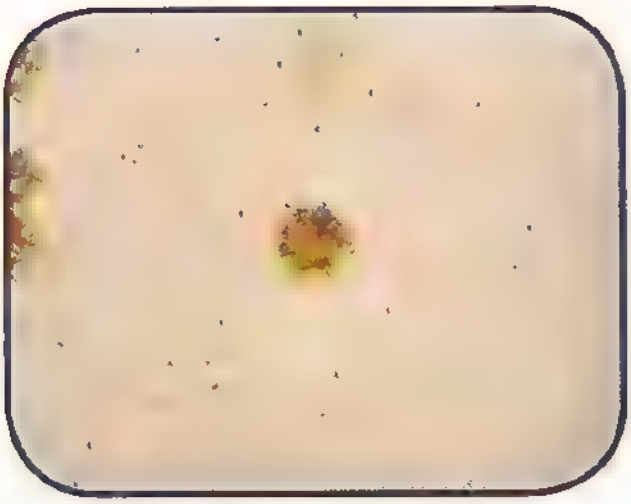


Fig. 3.31c: Bilirubin crystals (400x).

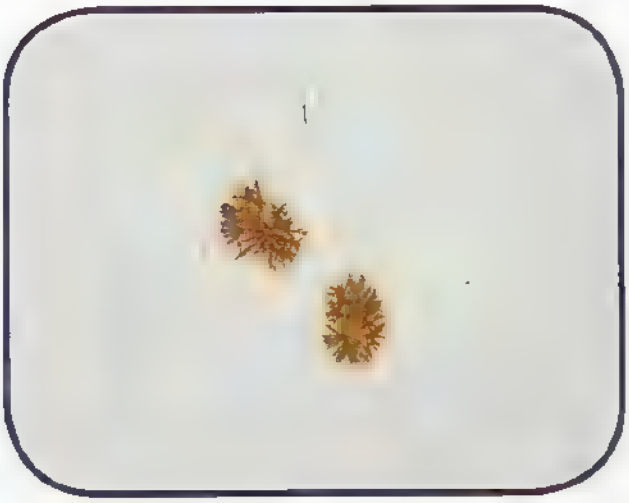


Fig. 3.32c: Needle shaped bilirubin crystals in clusters (400x).

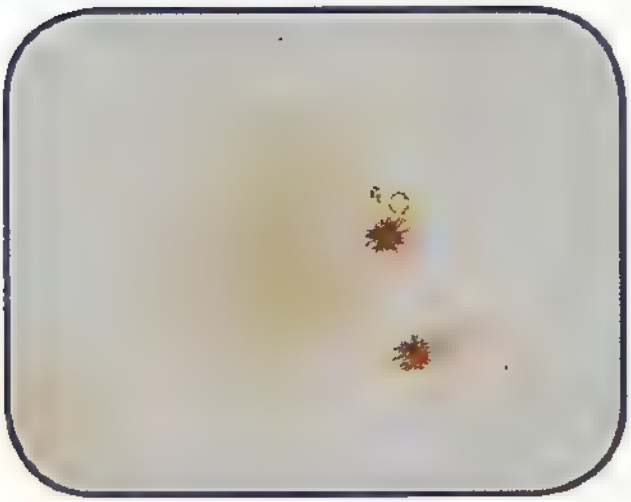


Fig. 3.33c: Bilirubin crystals (400x).

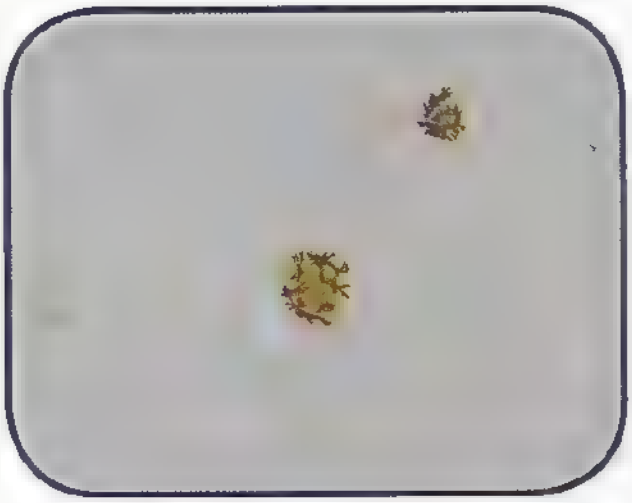


Fig. 3.34c: Bilirubin crystals (400x).

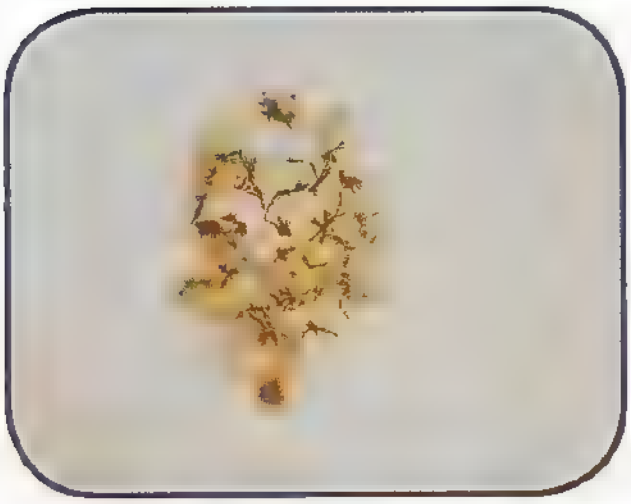


Fig. 3.35c: Bilirubin crystals (400x).

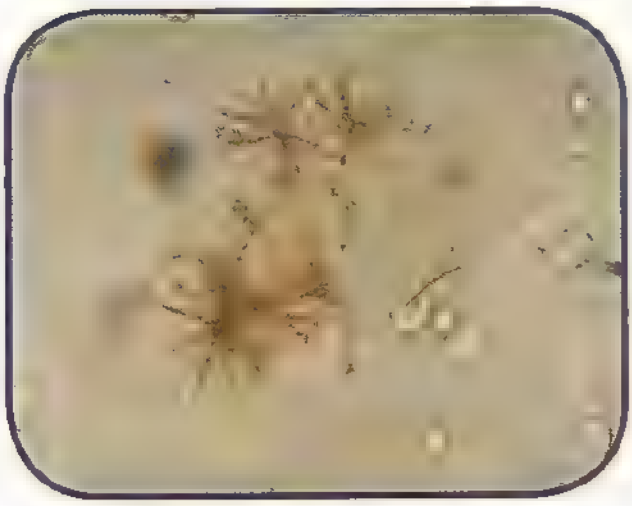


Fig. 3.36c: Bilirubin crystals (400x).

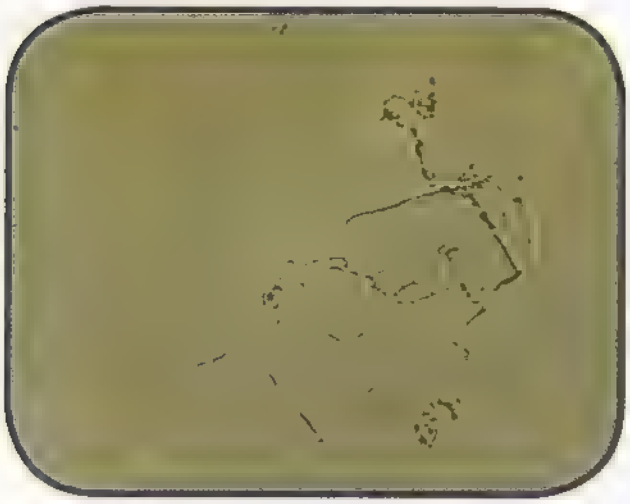


Fig. 3.37c: Cholesterol crystals in clusters (400x).

Fig. 3.38c. Cholesterol crystals. Notice the notched corners (400x).

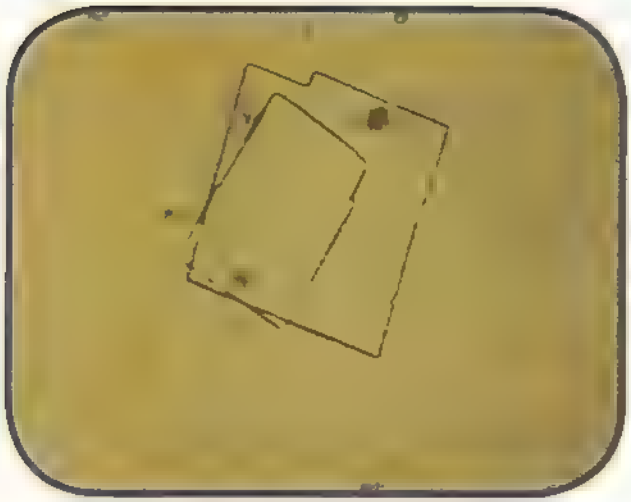


Fig. 3.39c: Cholesterol crystals (400x).

Fig. 3.40c: Cholesterol crystals (400x).

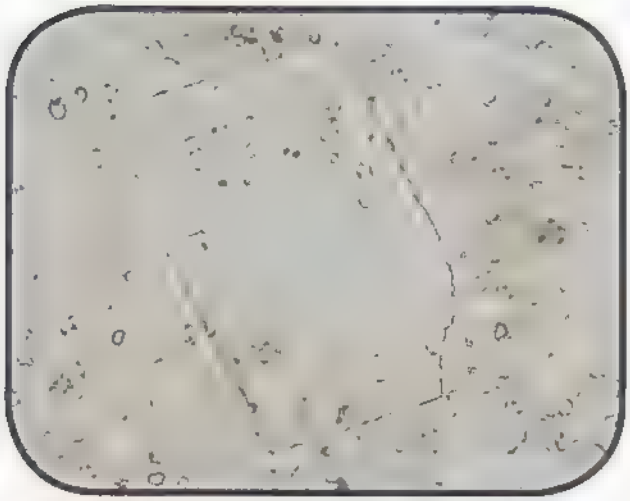


Fig. 3.41c: Cholesterol crystals and white blood cells (400x).

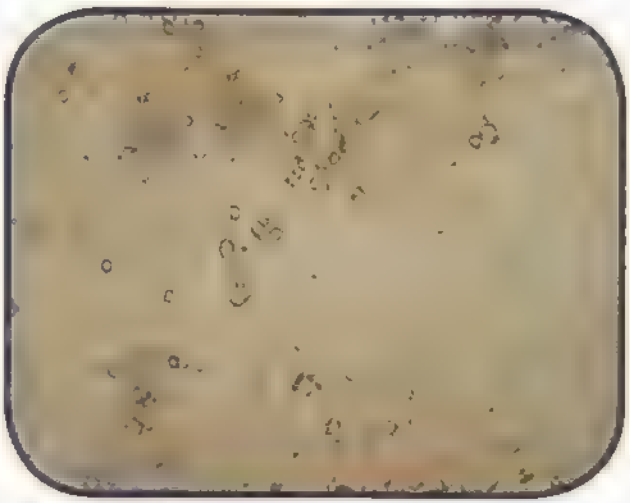


Fig. 3.42c: Cholesterol crystals and red blood cells (400x).

Fig. 3.43c Rosette and needle shaped of Calcium sulfate crystals (400x).

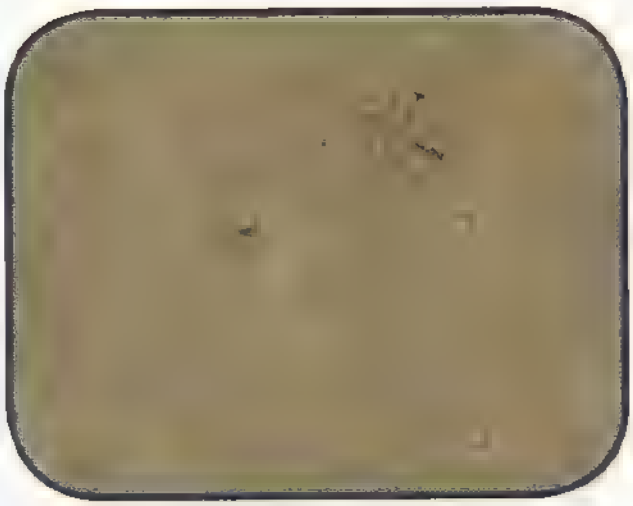


Fig. 3.44c: Calcium sulfate crystals (400x)

Fig. 3.45c Calcium sulfate crystals (400x).

Fig. 3.46c: Calcium sulfate crystals (400x).

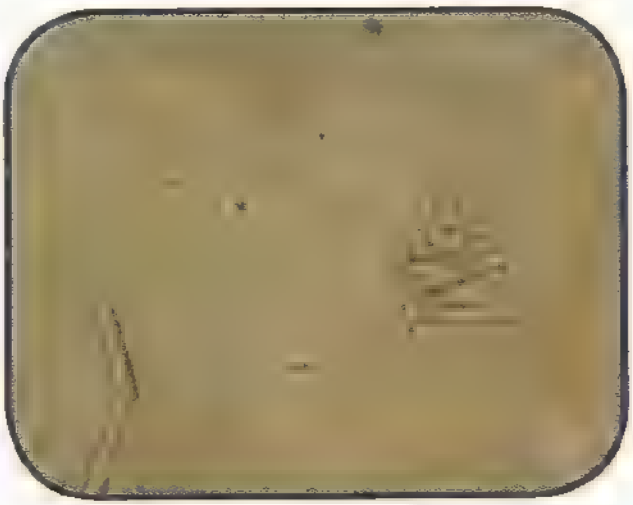


Fig. 3.47c. Calcium sulfate crystals in clusters (400x).

Fig. 3.48c: Needle shaped of calcium sulfate crystals (400x).

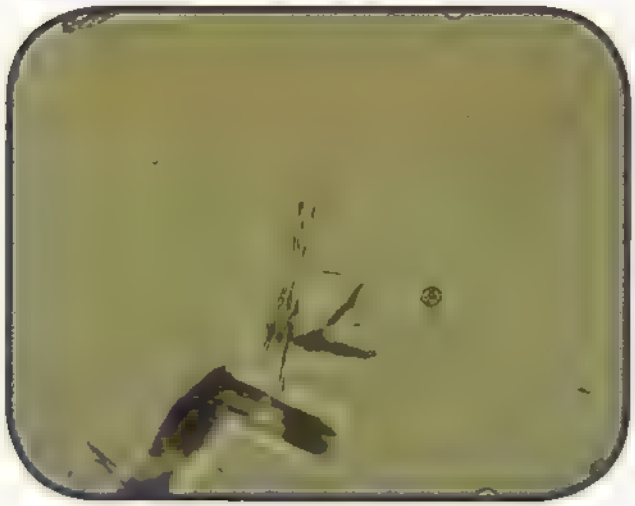


Fig. 3.49c: Tyrosine crystals and red blood cells (400x).

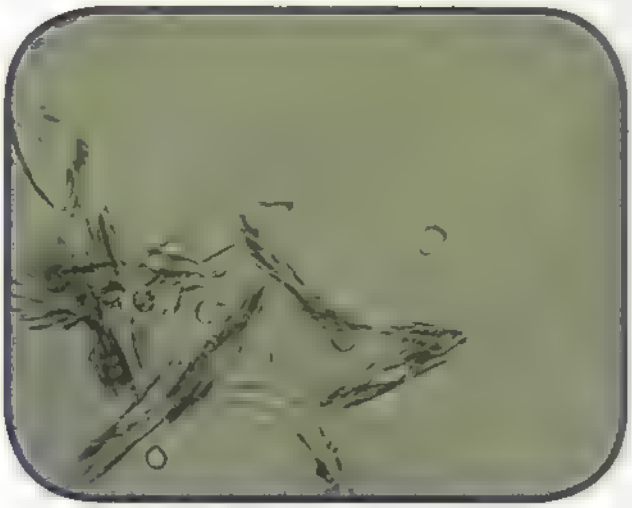


Fig. 3.50c: Tyrosine crystals in clusters (400x).

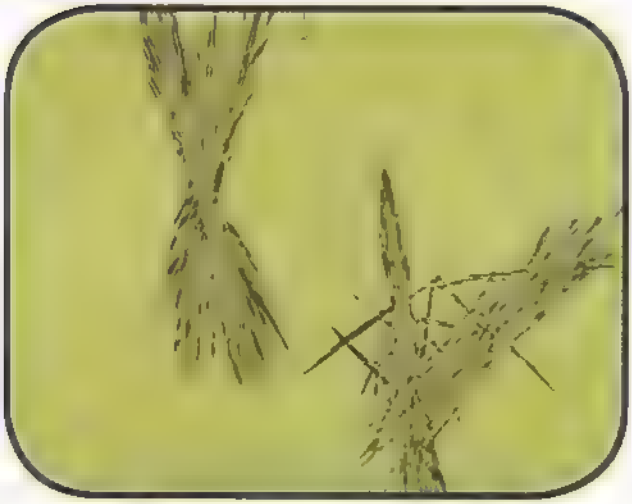


Fig. 3.51c: Tyrosine crystals (1000x).

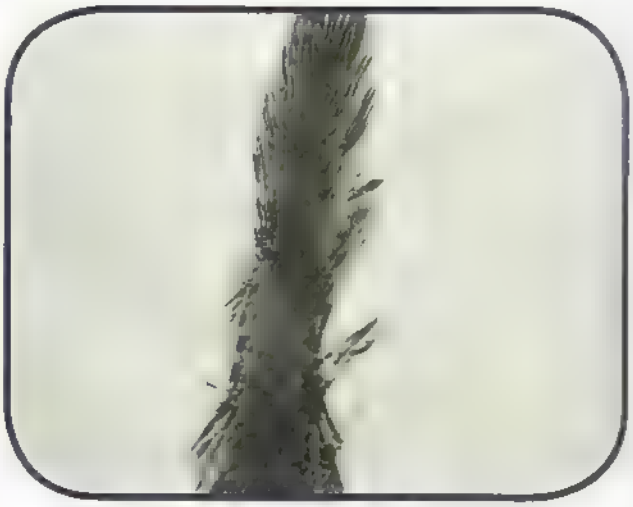


Fig. 3.52c: Tyrosine crystals (1000x).

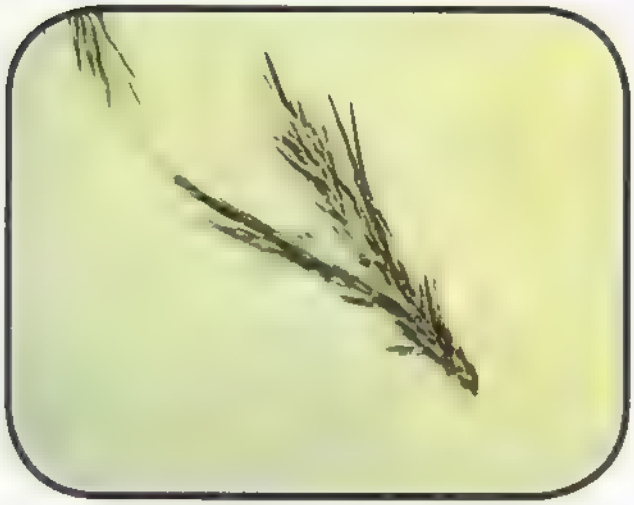


Fig. 3.53c: Tyrosine crystals (1000x).

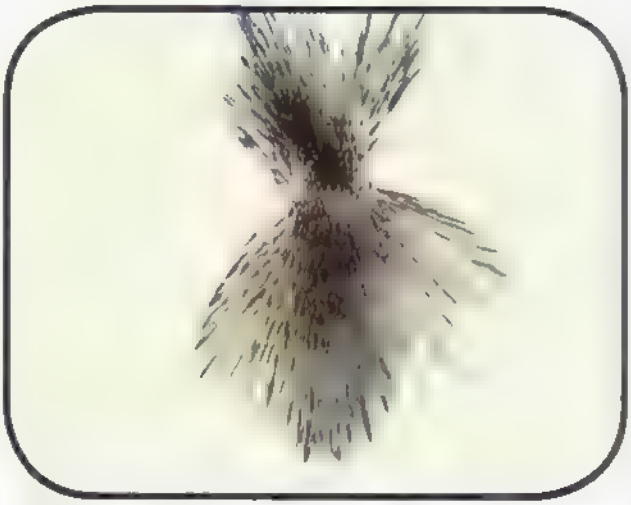


Fig. 3.54c: Tyrosine crystals. Notice the fine, very pointy needles (1000x).

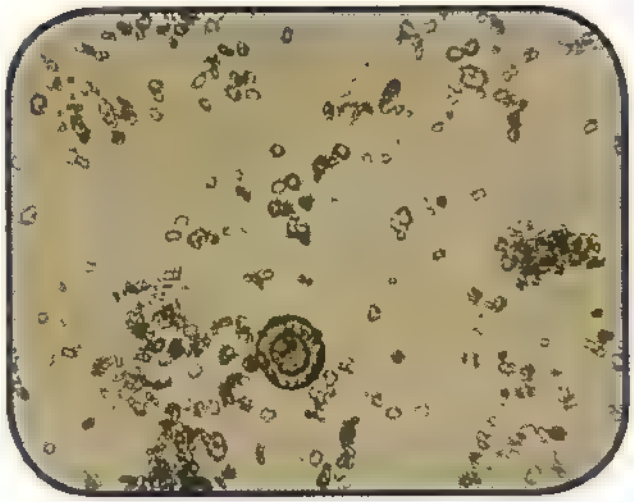


Fig. 3.55c: Leucine crystal (400x).

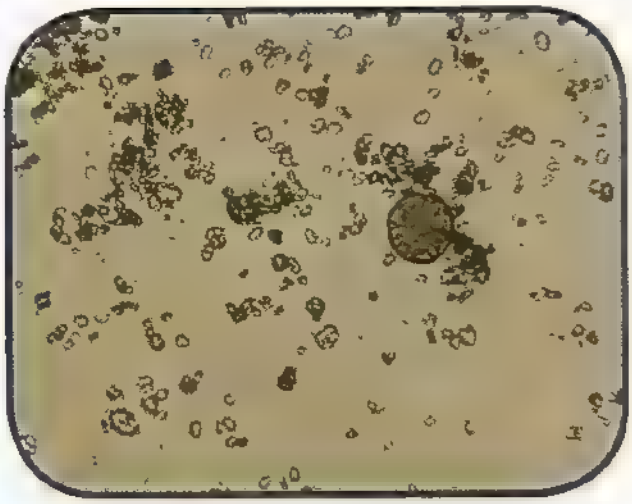


Fig. 3.56c: Leucine crystal (400x).

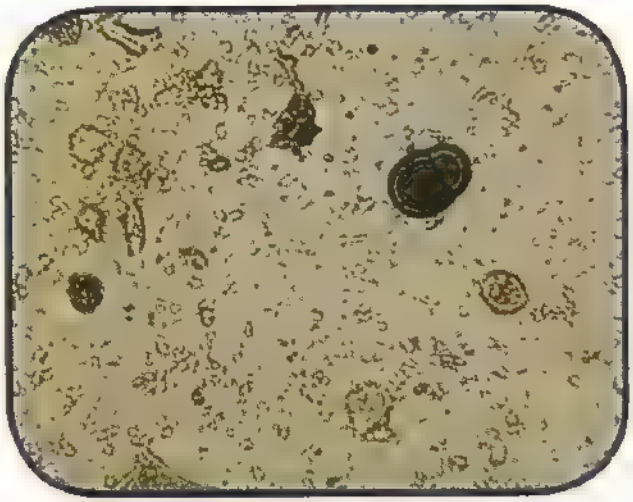


Fig. 3.57c: Leucine crystals (400x).

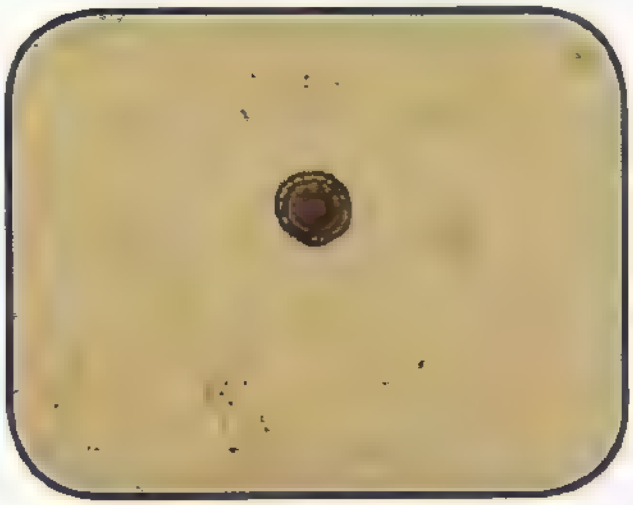


Fig. 3.58c: Leucine crystal. Notice the concentric circle (400x).

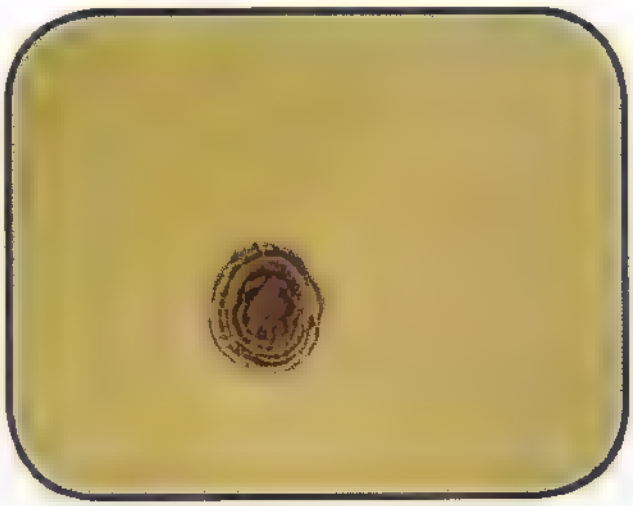


Fig. 3.59c: Leucine crystal (400x).

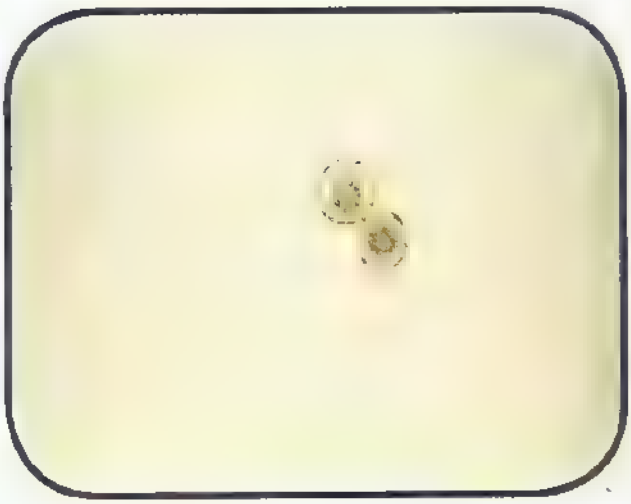


Fig. 3.60c: Leucine crystals (400x).

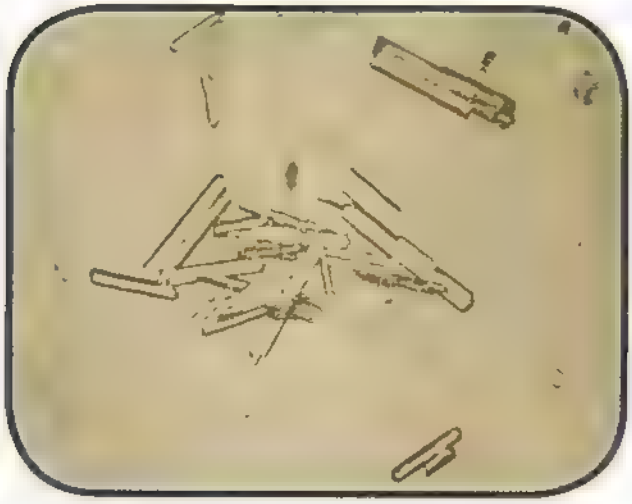


Fig. 3.61c. Hippuric acid crystals (400x)

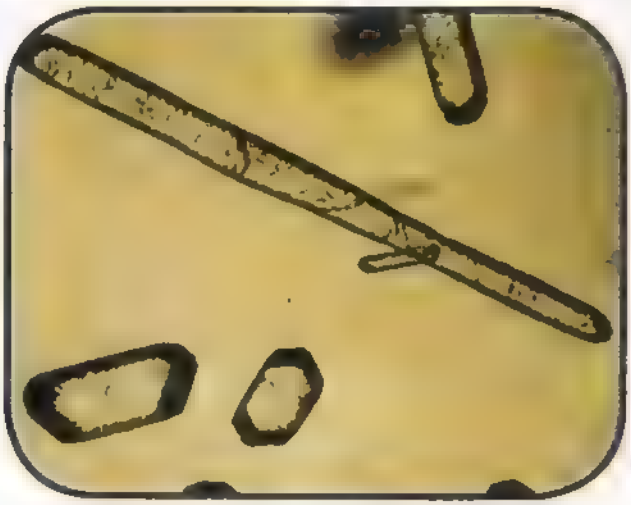


Fig. 3.62c Hippuric acid crystals (400x).

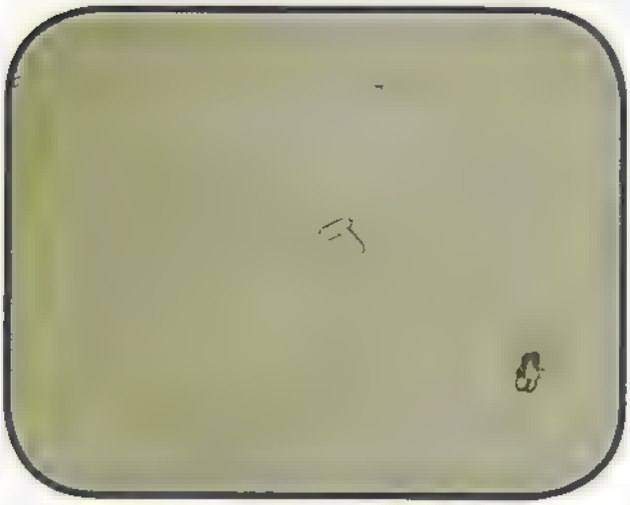


Fig. 3.63c Hippuric acid crystals (400x).

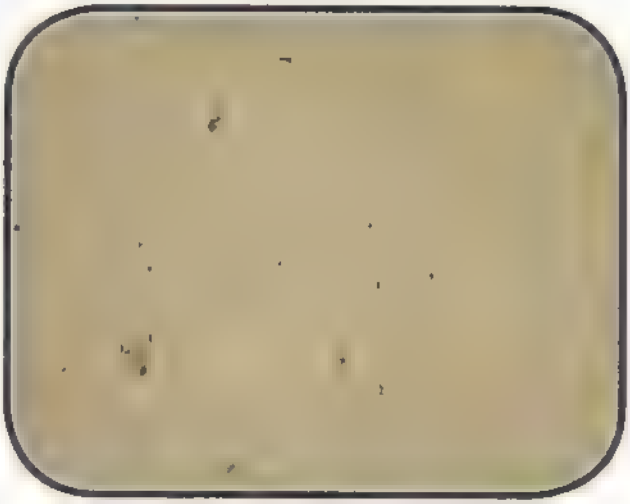


Fig. 3.64c. Hippuric acid crystal (400x).

Fig. 3.65c: Hippuric acid crystals (400x).

Fig. 3.66c: Hippuric acid crystals (400x).

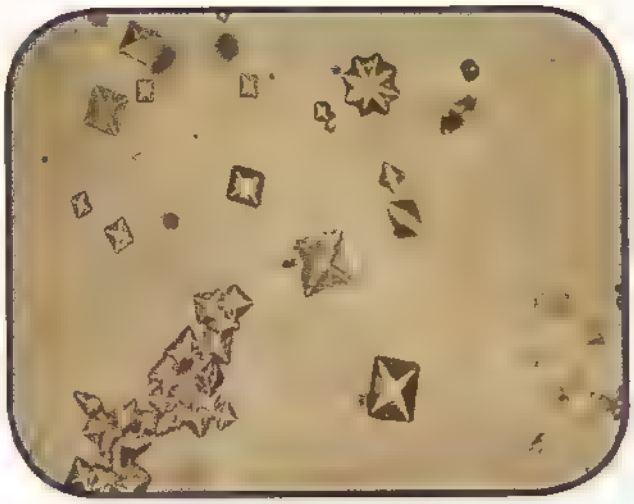


Fig. 3.67c: Dihydrate calcium oxalate crystals. Notice star-shaped (400x).

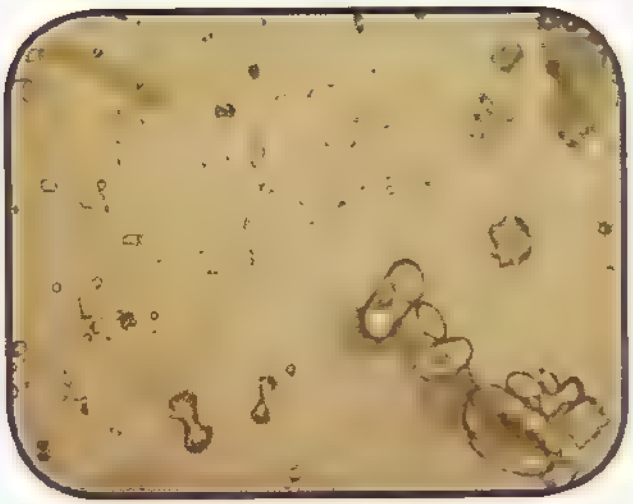


Fig. 3.68c: Oval shaped monohydrate calcium oxalate crystals (400x).

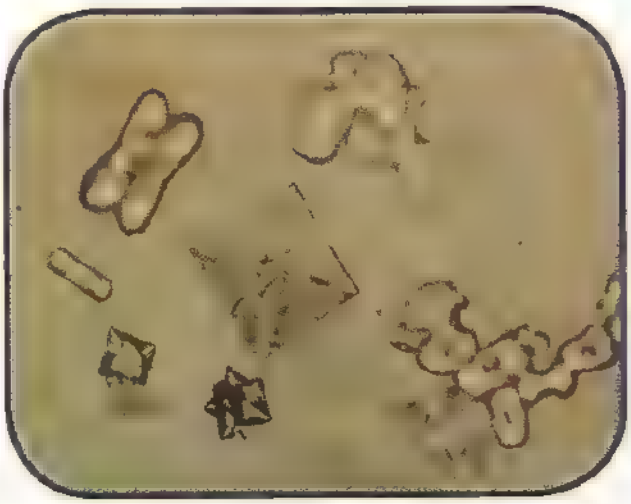


Fig. 3.69c: Mono and dihydrate calcium oxalate crystals. Notice the dumbbells shaped (400x).

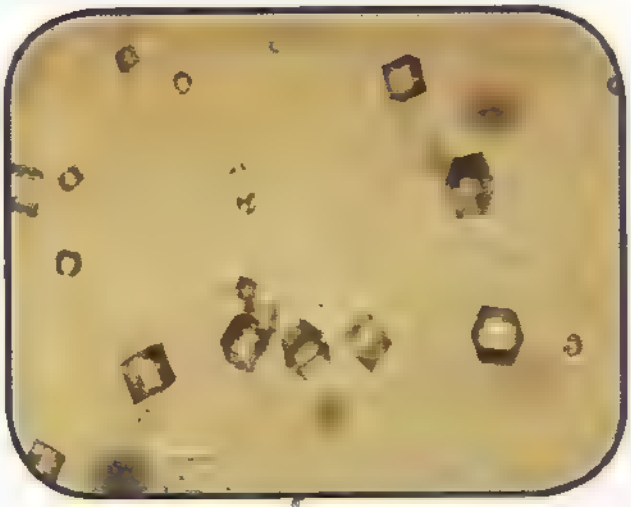


Fig. 3.70c: Calcium oxalate crystals unusual shaped (400x).

Fig. 3.71c: Calcium oxalate crystals rare unusual and star shaped (400x).

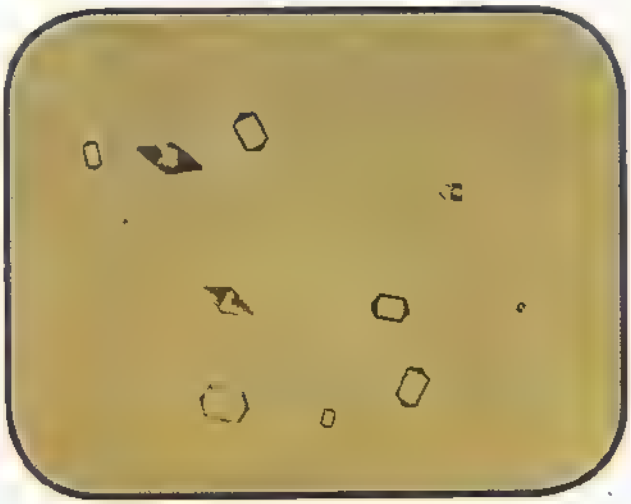


Fig. 3.72c: Calcium oxalate unusual shaped. Notice the prism shaped (400x).

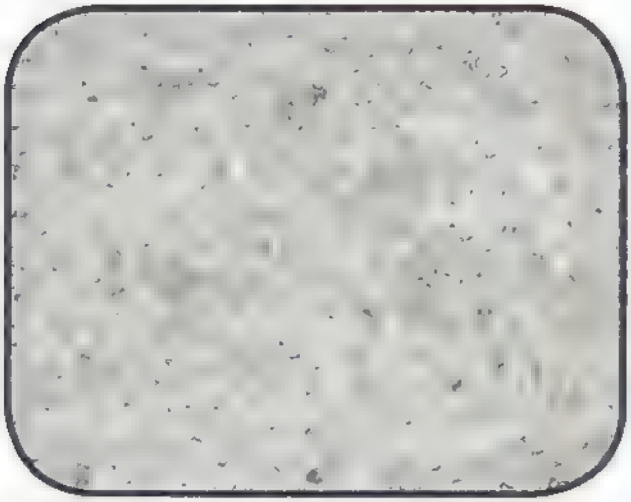


Fig. 3.73c: Amorphous phosphates (200x).

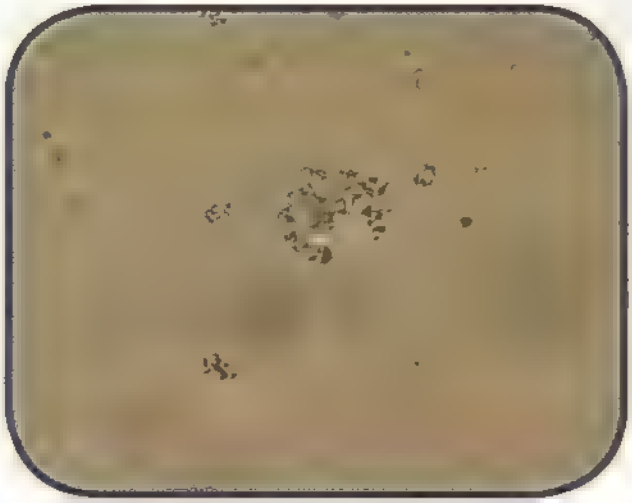


Fig. 3.74c: Amorphous phosphates (100x).

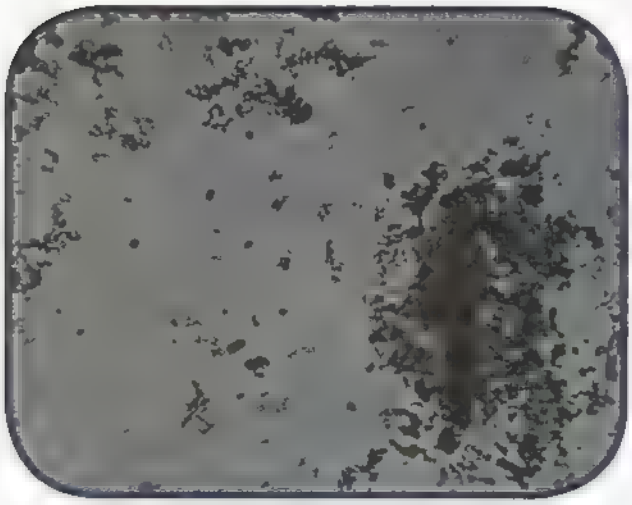


Fig. 3.75c: Amorphous phosphates (400x).

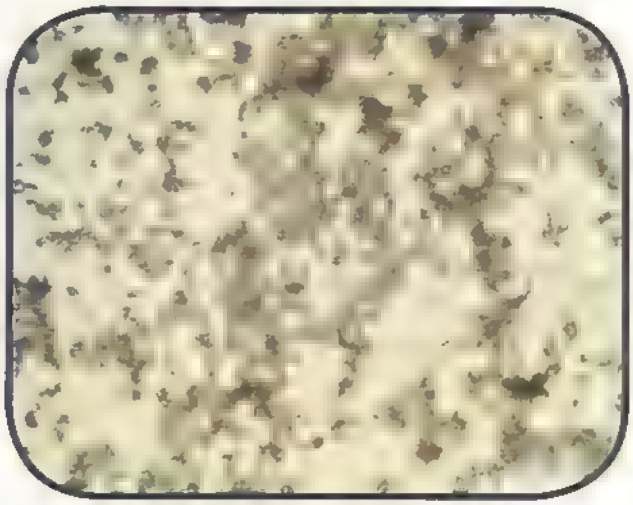


Fig. 3.76c: Amorphous phosphates (200x).

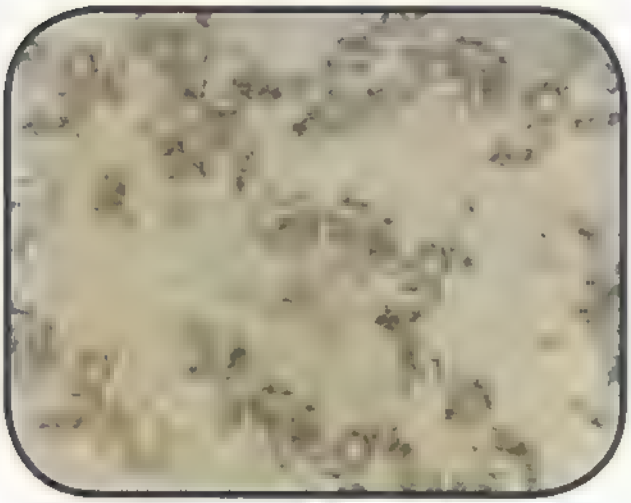


Fig. 3.77c: Amorphous phosphates (200x).

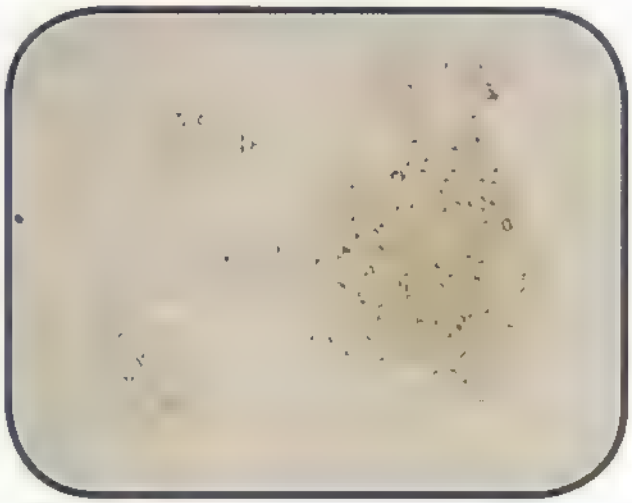


Fig. 3.78c: Amorphous phosphates (400x).

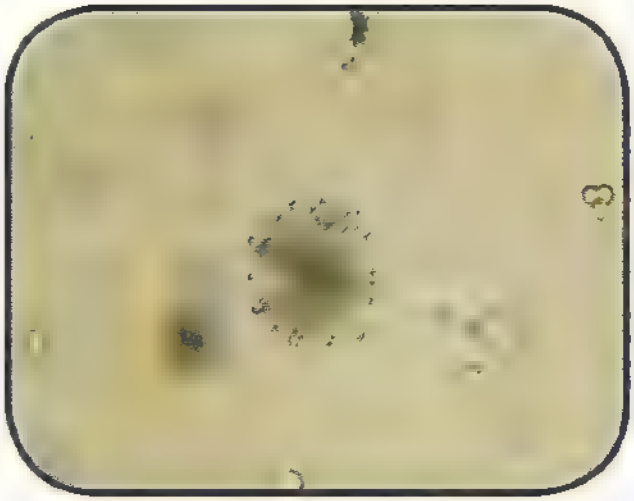


Fig. 3.79c: Rosette shaped of dicalcium phosphate crystals (400x).

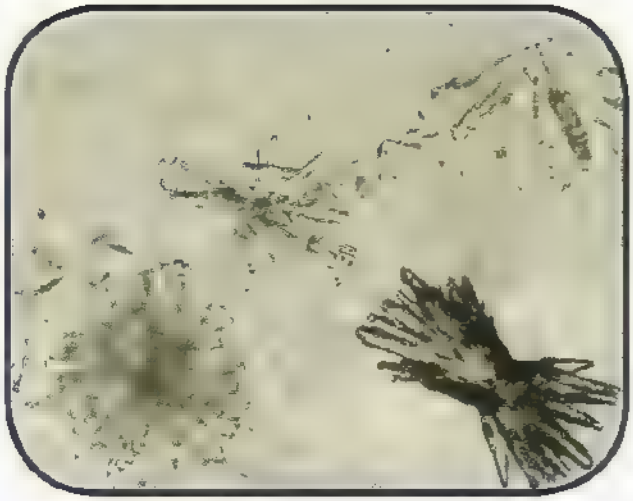


Fig. 3.80c: Various shapes of dicalcium phosphate crystals (400x).

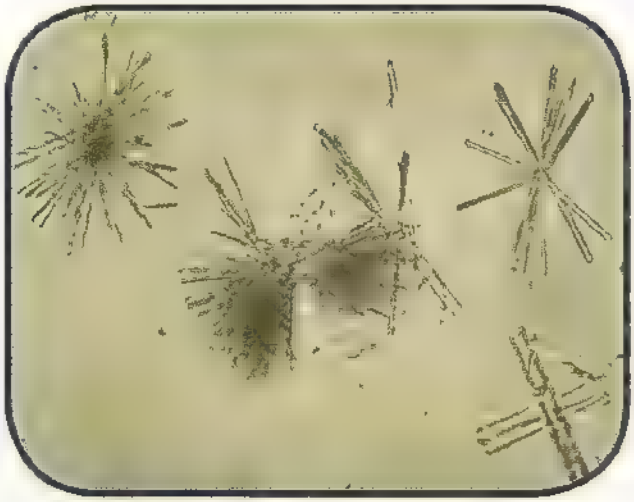


Fig. 3.81c. Dicalcium phosphate crystals (400x).

Fig. 3.82c Calcium phosphate and dicalcium phosphate crystals (400x).

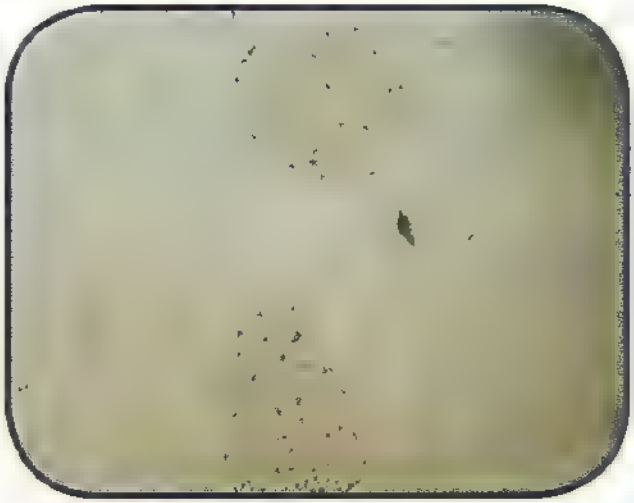


Fig. 3.83c: Plate shaped calcium phosphate crystals (400x).

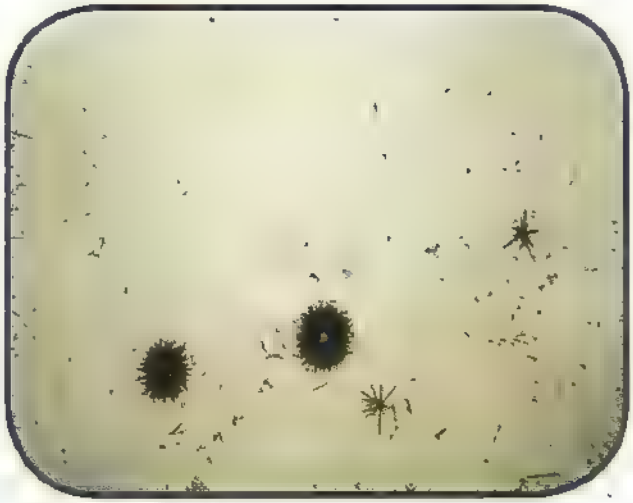


Fig. 3.84c: Calcium phosphate and dicalcium phosphate crystals (400x).

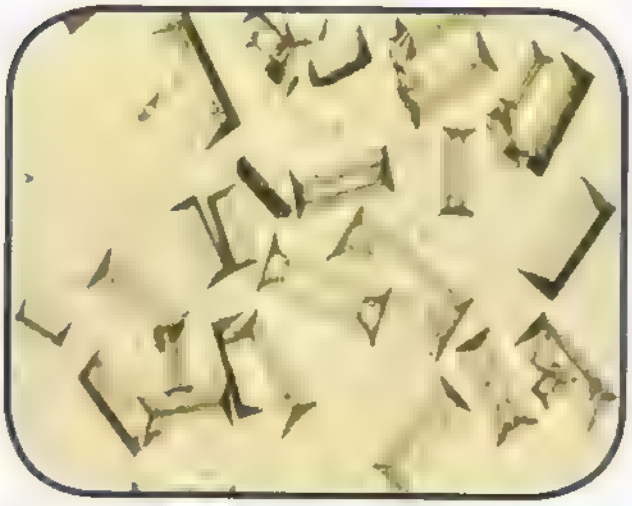


Fig. 3.85c: Triple phosphate coffin lid shaped (400x).

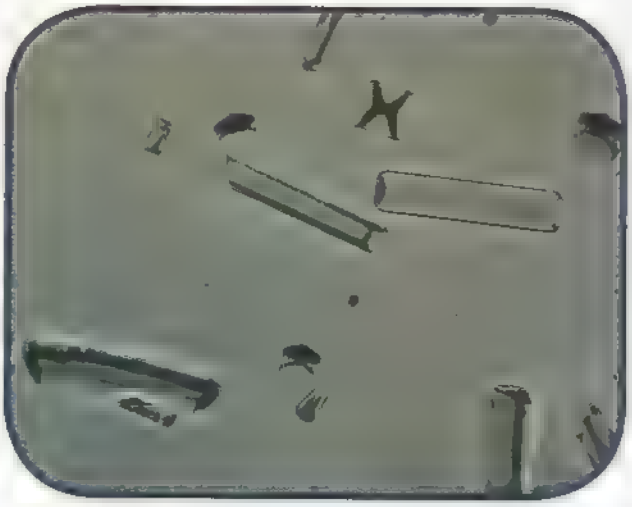


Fig. 3.86c: Triple phosphate crystals (400x)

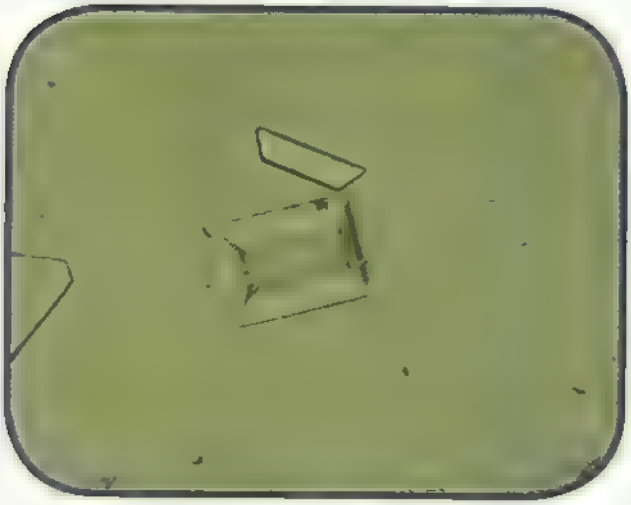


Fig. 3.87c: Triple phosphate crystals (250x).

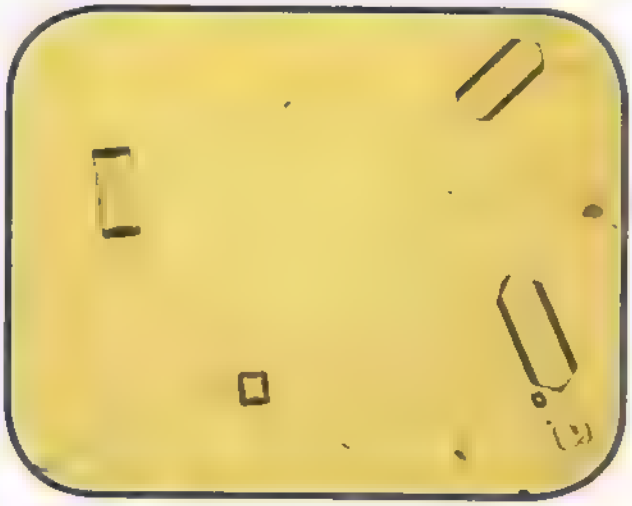


Fig. 3.88c: Triple phosphate crystals (400x)

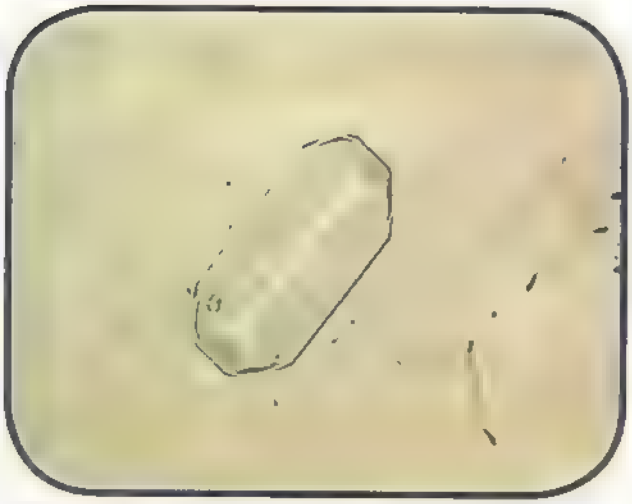


Fig. 3.89c: Triple phosphate crystals (400x).

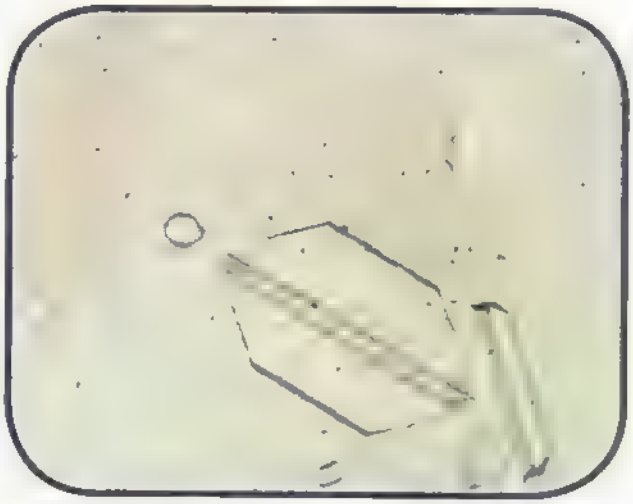


Fig. 3.90c: Triple phosphate crystals (400x).

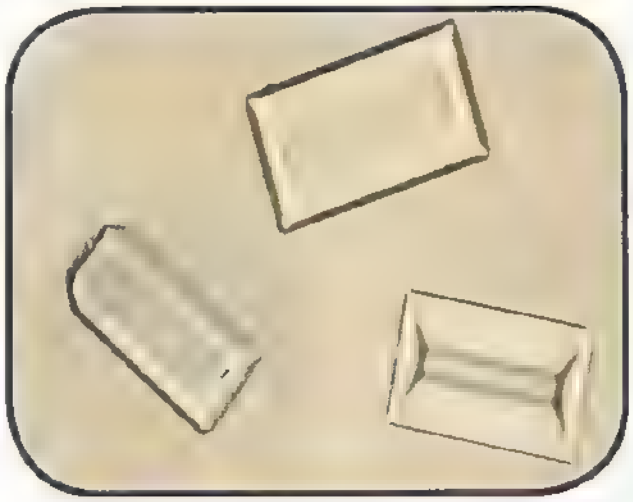


Fig. 3.91c: Triple phosphate crystals (400x).

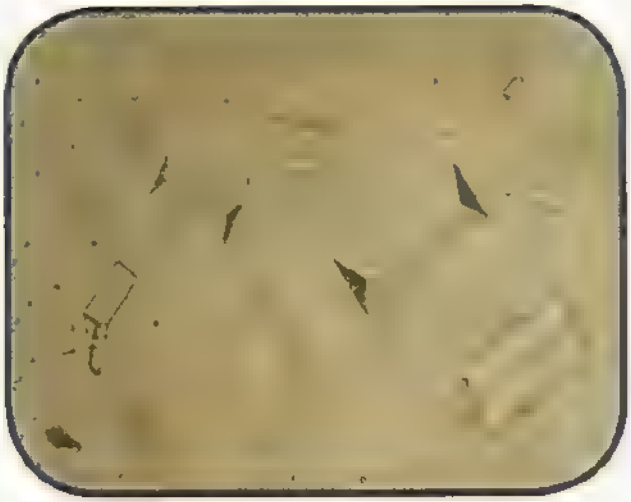


Fig. 3.92c: Triple phosphate crystals (400x).

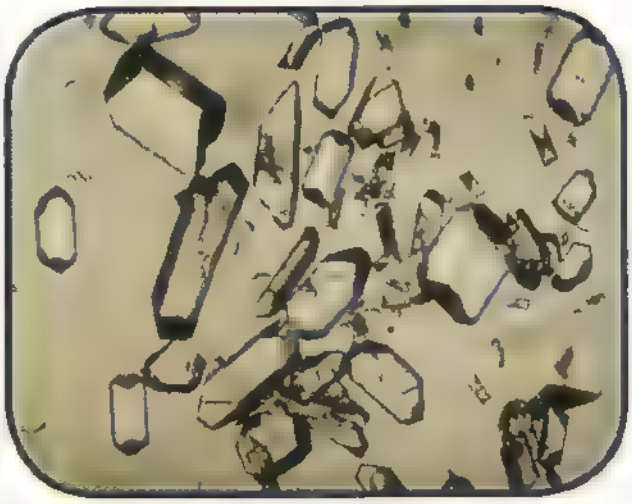


Fig. 3.93c: Triple phosphate crystals (400x).

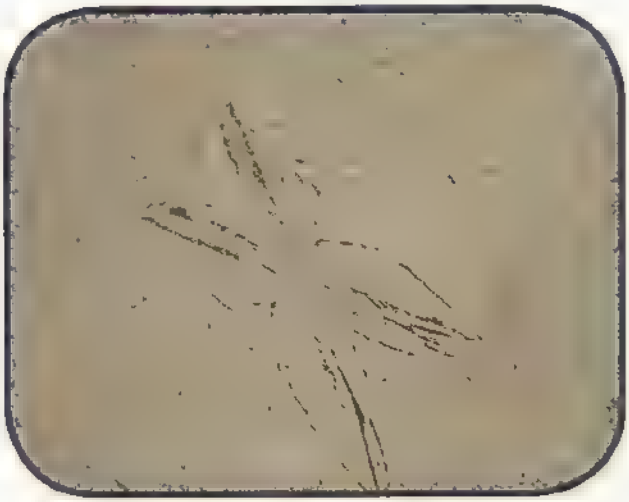


Fig. 3.94c: Feathers or fern shaped triple phosphate crystals (400x).

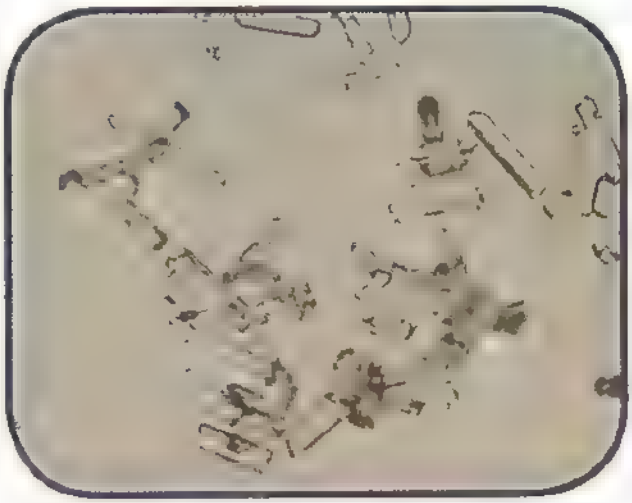


Fig. 3.95c: Triple phosphate crystals (200x).

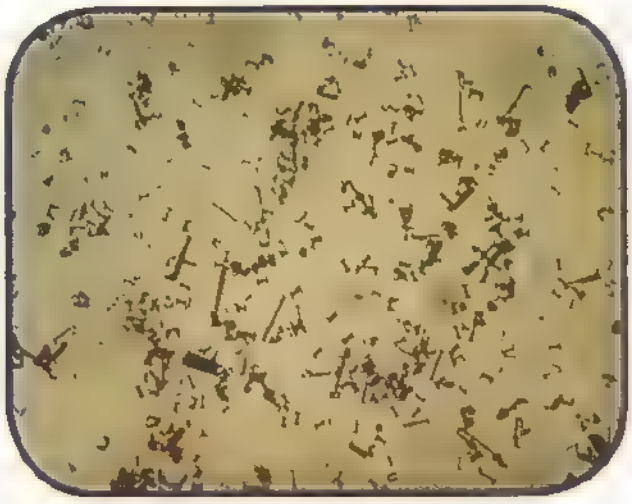


Fig. 3.96c: Triple phosphate crystals (100x).

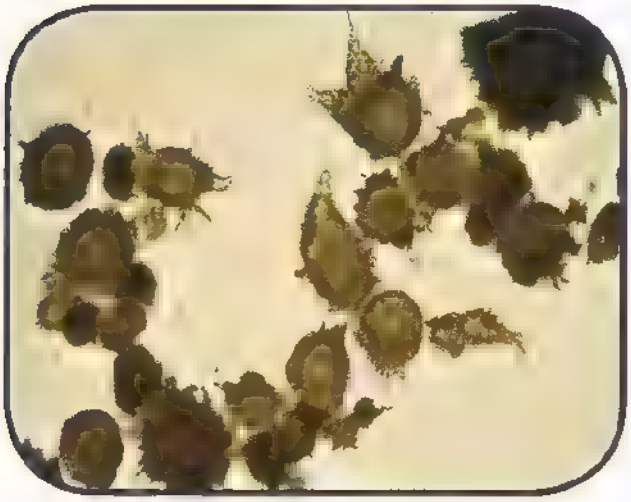


Fig. 3.97c: Ammonium biurate crystals. Notice the typical morula form with spicules (400x)

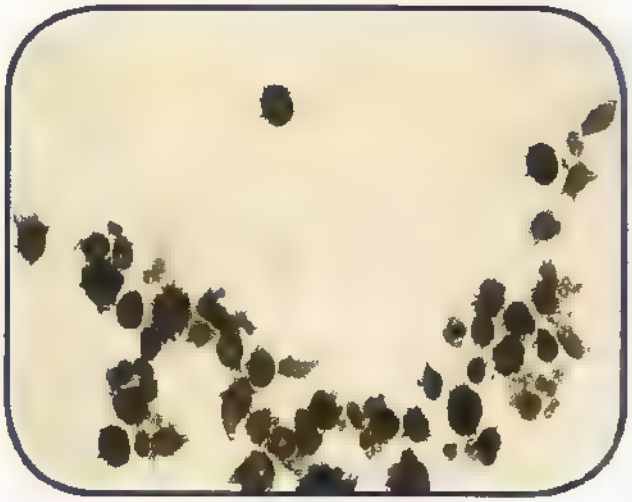


Fig. 3.98c: Ammonium biurate crystals (100x).

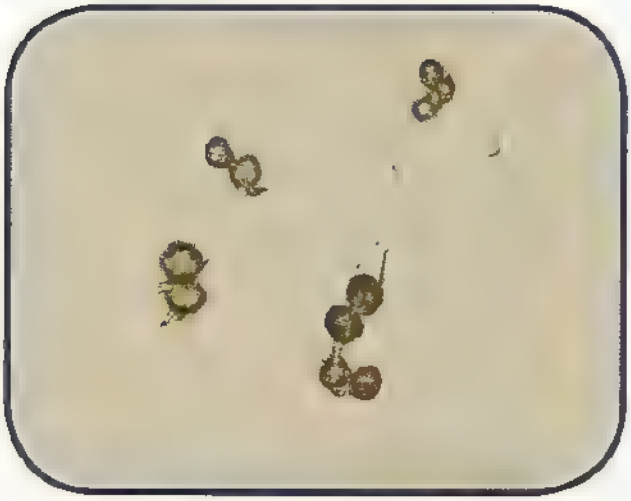


Fig. 3.99c: Ammonium biurate crystals (400x).

Fig. 3.100c: Ammonium biurate crystals (400x).

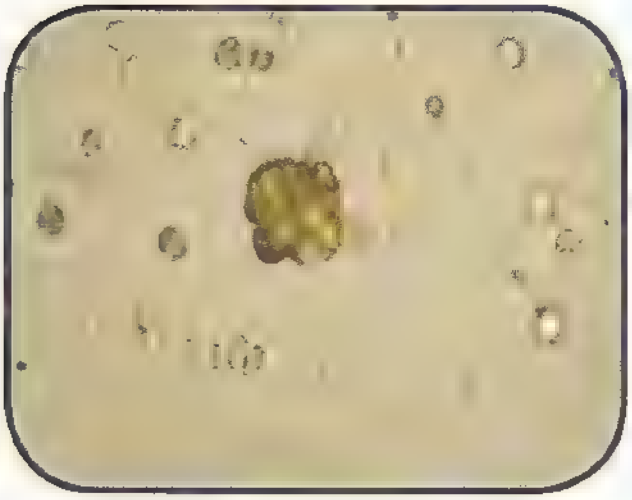


Fig. 3.101c. Ammonium biurate crystals (400x).

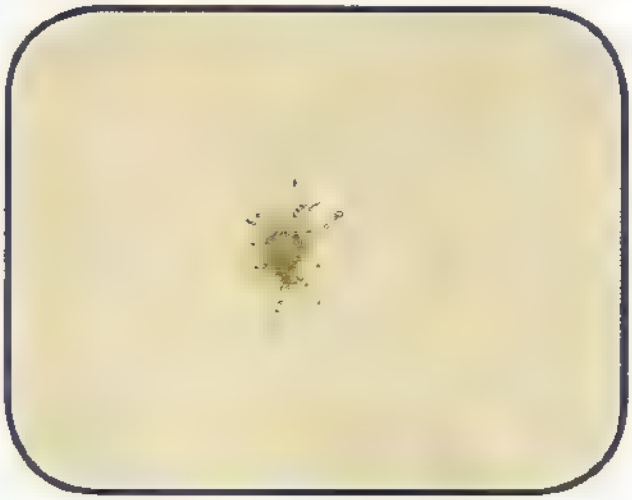


Fig. 3.102c. Ammonium biurate crystals (400x).

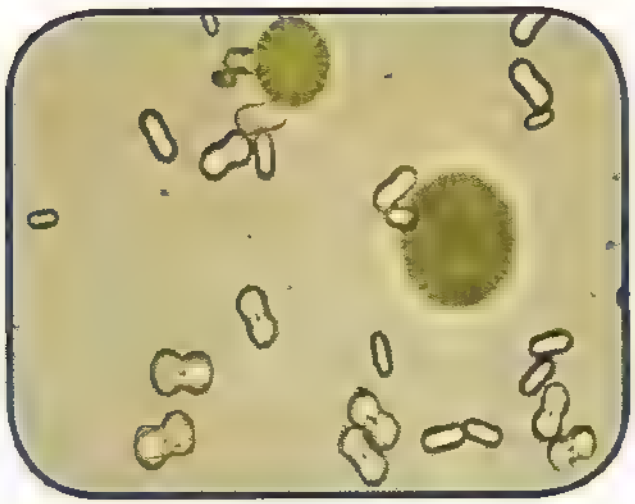


Fig. 3.103c: Calcium carbonate crystals. Notice the dumbbell shaped (400x)

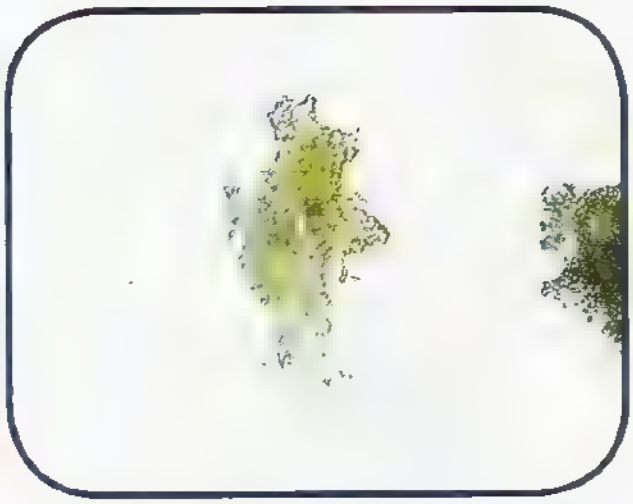


Fig. 3.104c. Calcium carbonate crystals. Notice "dumbbell" next to large mass of calcium carbonate (400x).

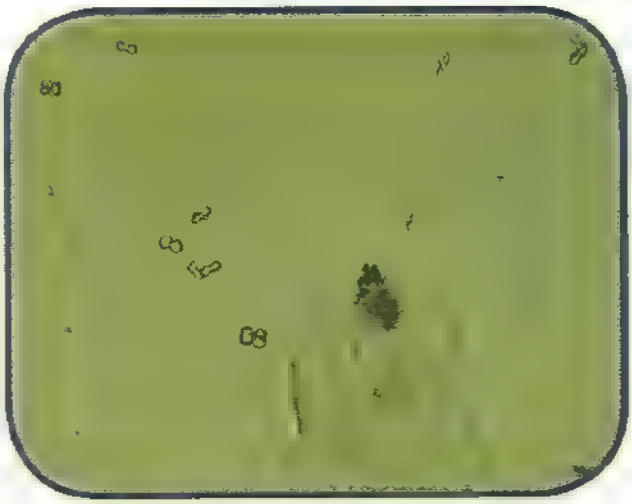


Fig. 3.105c: Calcium carbonate crystals (400x).

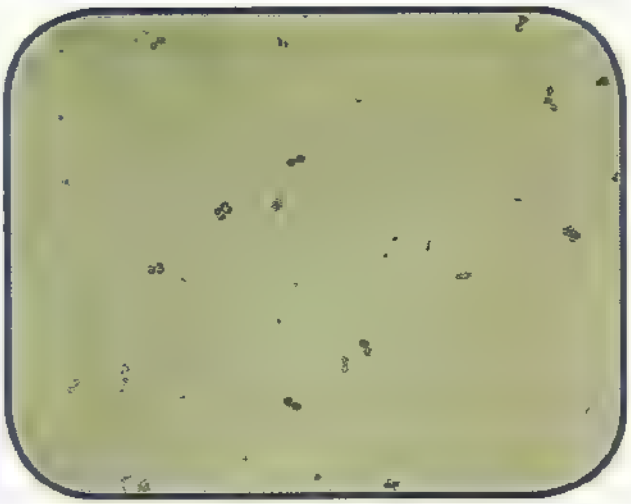


Fig. 3.106c. Calcium carbonate crystals (100x).

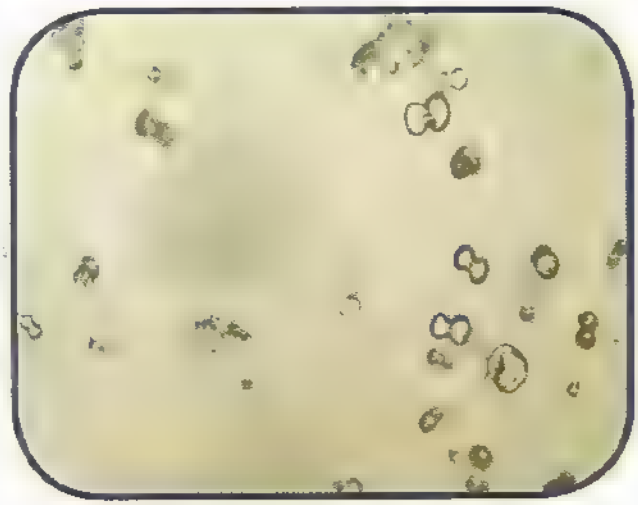


Fig. 3.107c: Calcium carbonate crystals (400x).

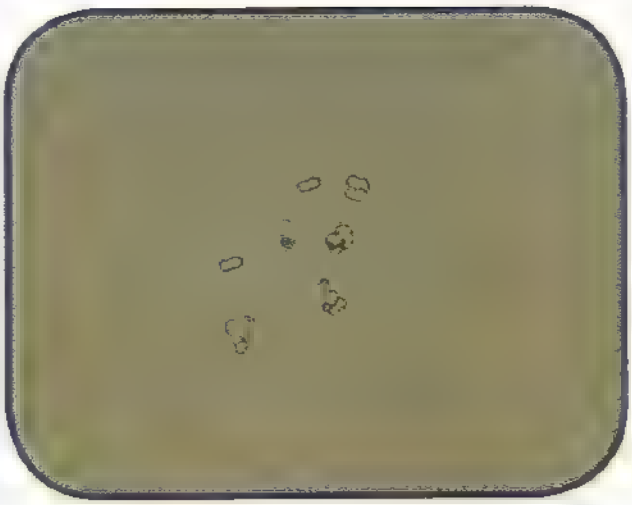


Fig. 3.108c: Calcium carbonate crystals (400x).

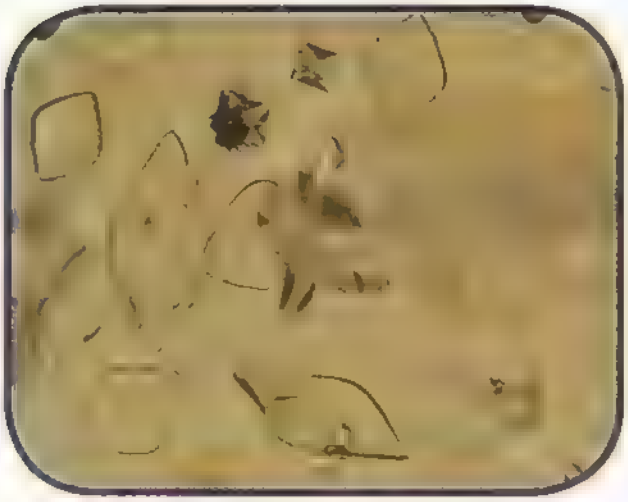


Fig. 3.109c: Uric acid and calcium oxalate crystals (400x).

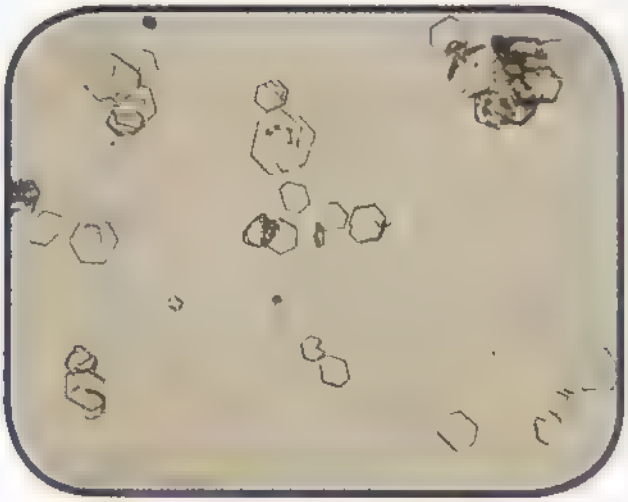


Fig. 3.110c: Cystine and calcium oxalate crystals (100x).

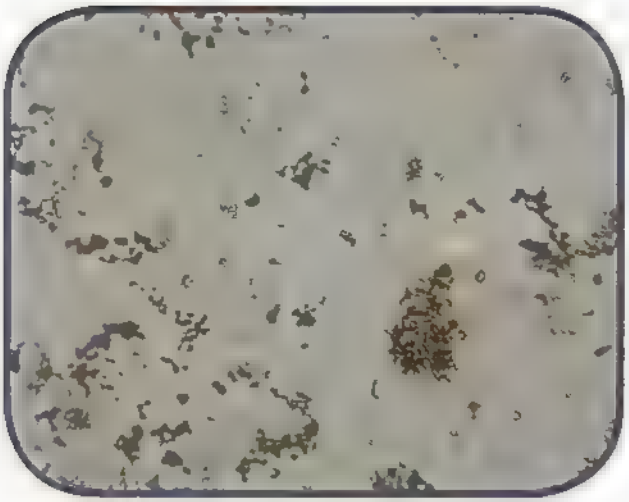


Fig. 3.111c: Amorphous urates and bilirubin crystals (400x).

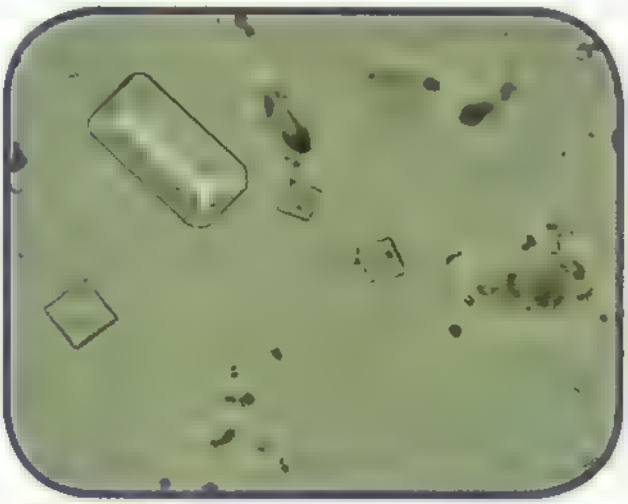


Fig. 3.112c: Triple phosphate and calcium oxalate crystals (400x).

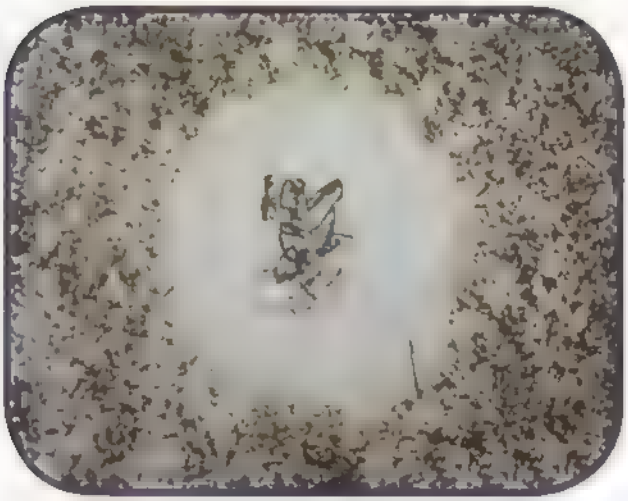


Fig. 3.113c: Amorphous urates and uric acid crystals (400x).

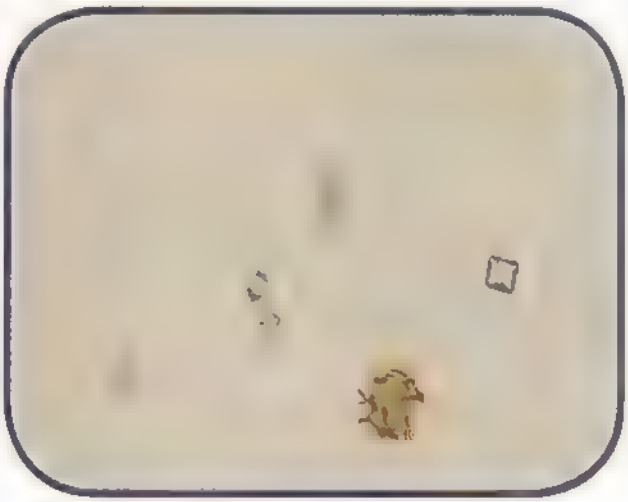


Fig. 3.114c: Calcium oxalate and bilirubin crystals (400x).

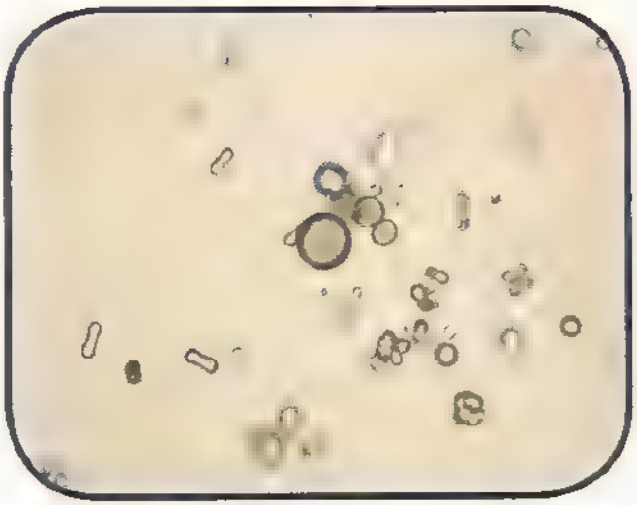


Fig. 3.115c. Calcium carbonate and calcium oxalate crystals (400x).

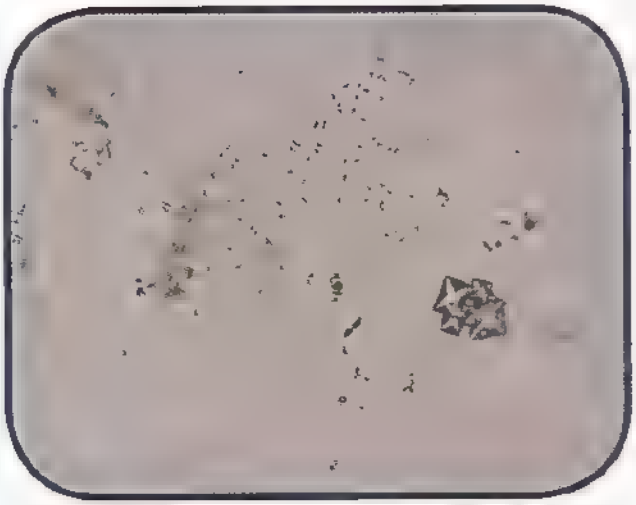


Fig. 3.116c: Calcium phosphate and calcium oxalate crystals (400x).

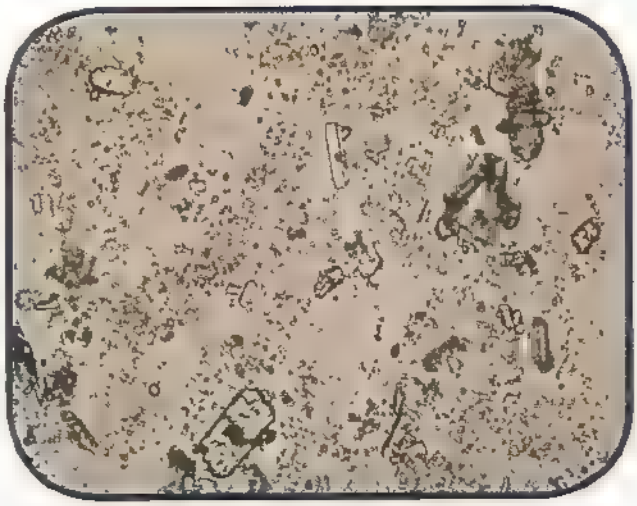


Fig. 3.117c. Amorphous phosphates and triple phosphate crystals (400x).

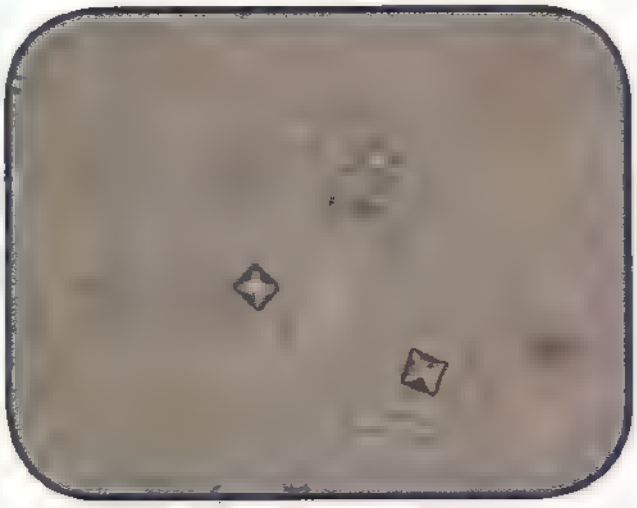


Fig. 3.118c: Calcium sulfate and calcium oxalate crystals (400x).

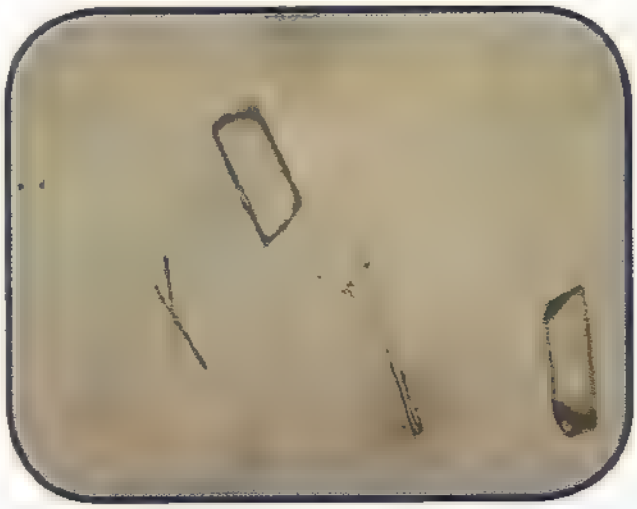


Fig. 3.119c: Triple phosphate and Dicalcium phosphate crystals (400x).

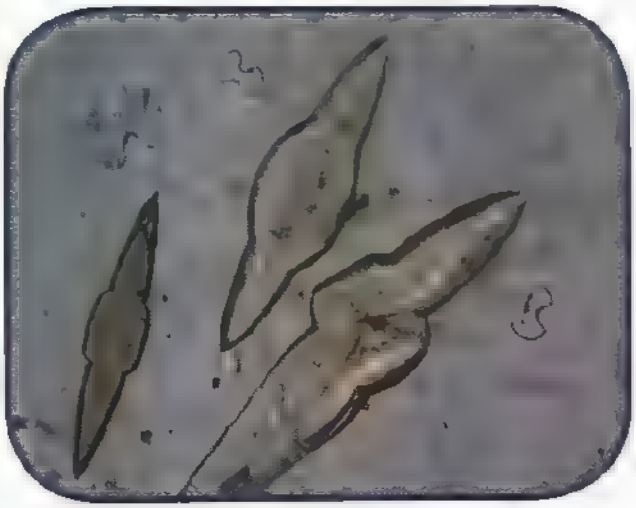


Fig. 3.120c Ca oxalate (Monohydrate) and uric acid (cross shaped) crystals (400x).

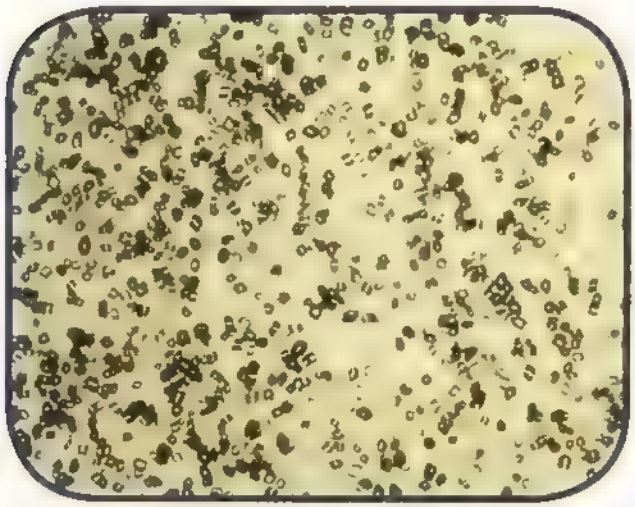


Fig. 3.121c: Sulfa crystals formation after cotrimoxazole therapy (100x).

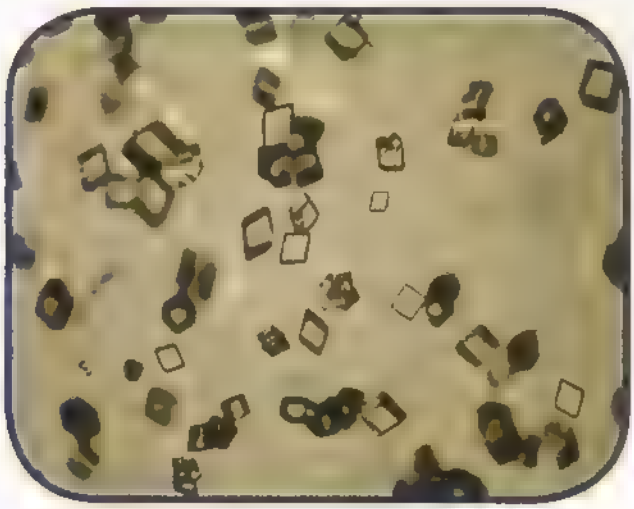


Fig. 3.122c: Same previous field (400x).

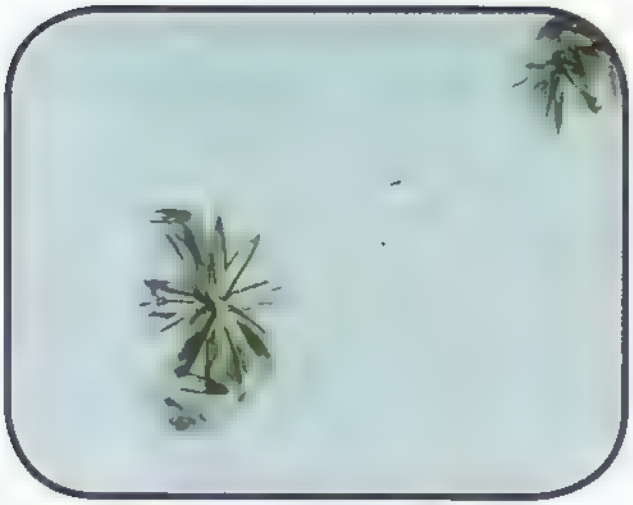


Fig. 3.123c: Rosette shaped sulfa crystals (400x).

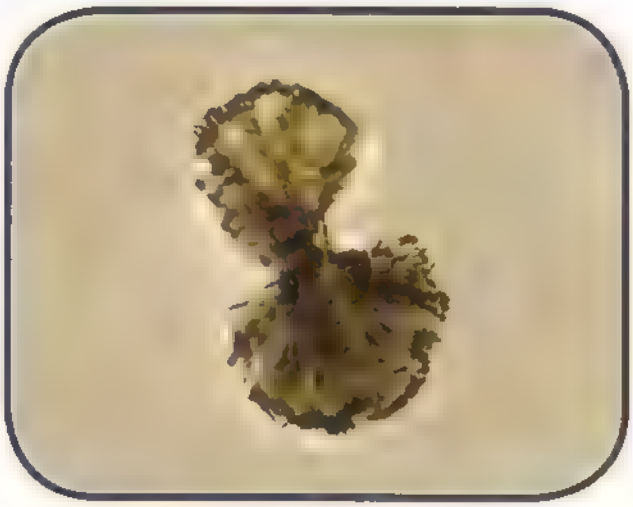


Fig. 3.124c: Sheave shaped sulfa crystals (400x).

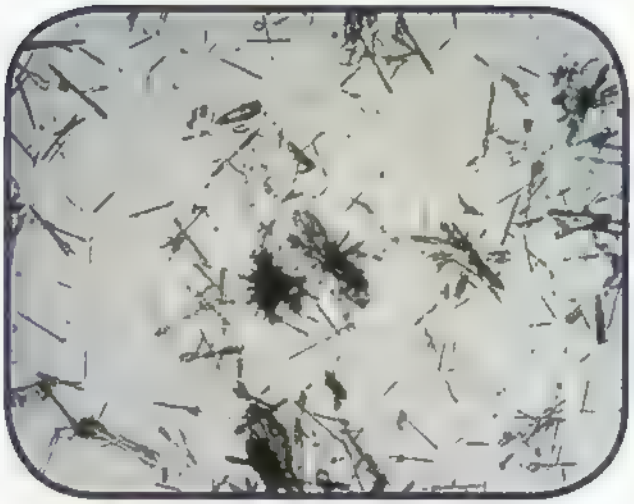


Fig. 3.125c: Ampicillin crystals following refrigeration (400x).

Fig. 3.126c: Ampicillin crystals non refrigerated (400x).

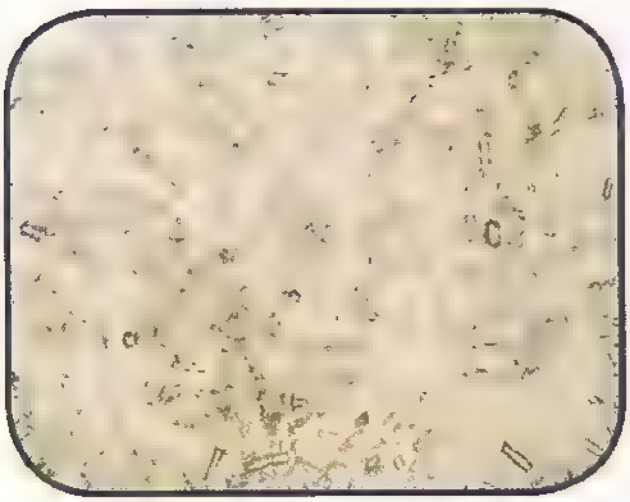


Fig. 3.127c: Crystals formation after intravaginally canesten (100x).

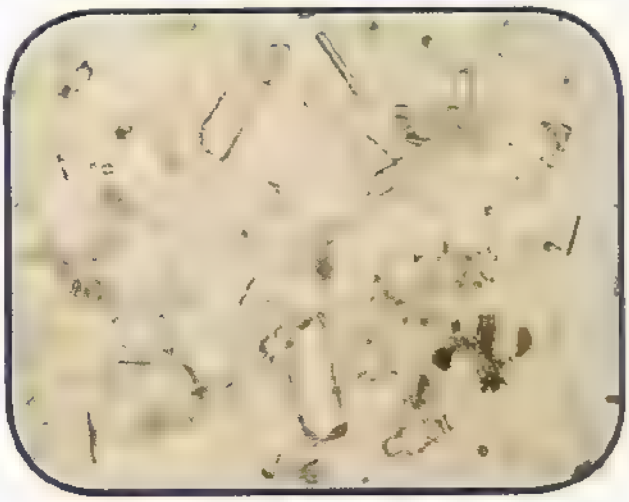


Fig. 3 128c: Same previous filed (400x)

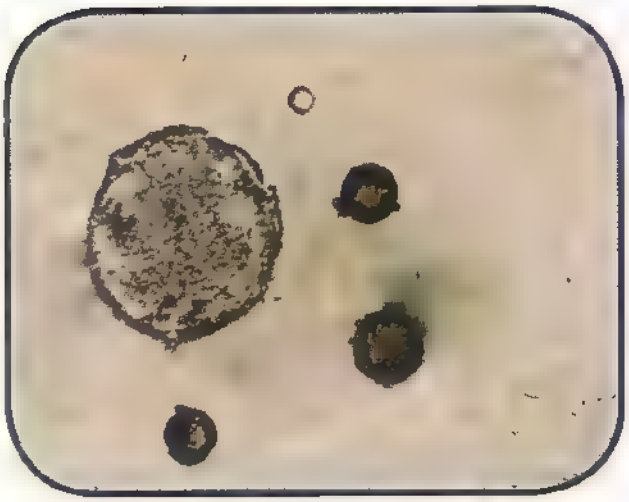


Fig. 3 129c Metronidazole crystals appear after contamination of sediments by vaginal tablets (400x).

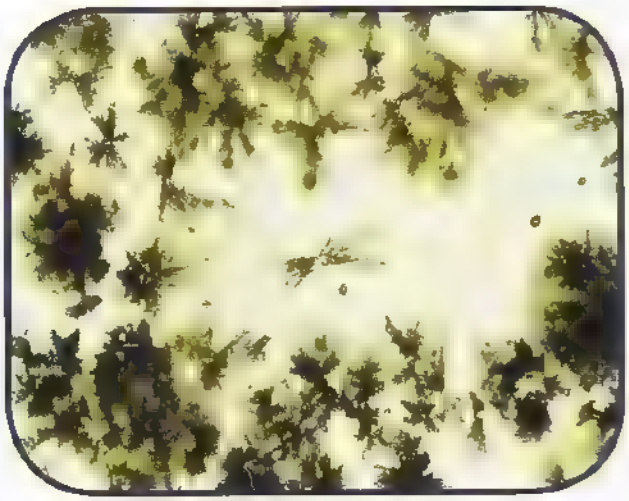


Fig 3.130c. Radiographic dye crystals (Hypaque) (400x).

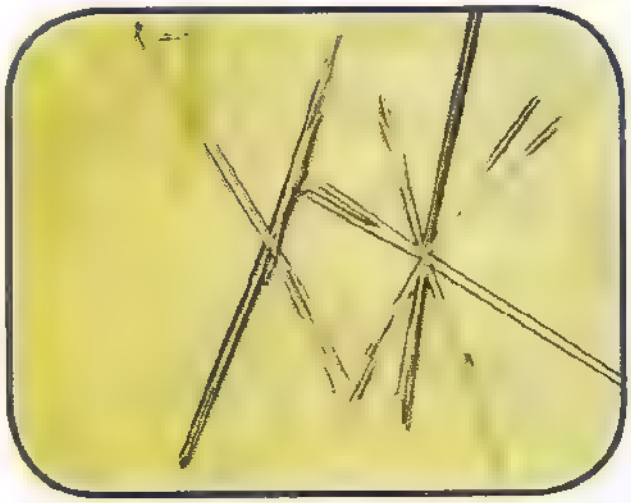


Fig. 3 131c Radiographic dye crystals (Renografin) (400x).

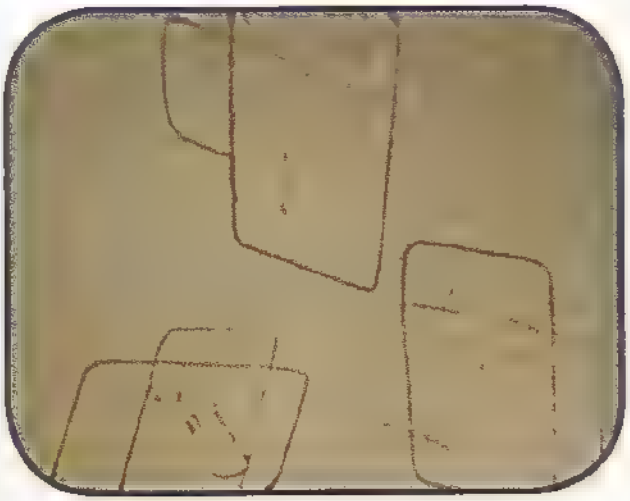


Fig. 3.132c: Radiographic dye crystals (400x).

Parasites

Parasites common seen in urine

1) *Trichomonas vaginalis*

- *Trichomonas vaginalis* (Trophozoite) is easily identified in wet preparations of the urine sediment by its rapid darting movement in the microscopic field .
- It is round to lemon-pear shape similar in size with WBC and RTE.
- The trophozoite is more difficult to identify and may be misdiagnosed as a WBC, transitional, or RTE cell when not in motion.

2) *Schistosoma haematobium*

- The ovum of the *Schistosoma haematobium* is pale yellow-brown in color and large and oval in shape, measuring about 145x55 µm.
- It has a characteristic small spine at one end (terminal spine).
- It contains a fully developed miracidium and sometimes the miracidia hatch from the eggs and can be seen 'swimming' in the urine.

Parasites rare seen in urine

1) Microfilariae

Two types of microfilariae that may be found in urine that may be seen in wet preparation or stained smears. The larva of micrifilarae may be misdiagnosed with hairs

a) Wuchereria bancrofti

- *Wuchereria bancrofti* is rarely seen in urine. This happens when a urogenital lymphatic vessel ruptures .
- The urine appears milky-white or reddish-pink (chyle mixed with blood).
- The larvae are large (225-300 x10 µm), sheathed and motile in wet preparation.

b) Onchocerca volvulus

- *Onchocerca volvulus* may be found in the urine in onchocerciasis, especially in heavy infections.
- The larvae are large (280–330 x 7 µm), unsheathed, with a slightly enlarged head-end and a tail which is sharply pointed and contains no nuclei. They appear motile in wet preparation.

2) *Schistosoma mansoni*

- *Schistosoma mansoni* may live in the pelvic plexus and its ova can be detected in urine (mansonuria).
- The ovum is pale yellow-brown in color, large, and oval in shape, about 150x60 µm.

- The ovum has a characteristic side; lateral spine.

3) Hydatid sand

- Hydatid cyst is caused by *Echinococcus* species especially the *E. granulosus*.
- Individual protoscolece lying at the bottom of the large cyst are called "Hydatid sand".
- Ruptures of Hydatid cyst in the kidney lead to spread of protoscoleces and appear in urine.
- The protoscolece is round to oval in shape, measuring about 140 x 80µm. They may be invaginated or evaginated.

Parasites seen in urine due to sexual transmission or faecal contamination

1) *Entrobius vermicularis*

- *Enterobius vermicularis* (pinworm) ova and occasionally also the female adult may be found in the urine, perhaps even more frequently than was once believed.
- The ovum is colourless and oval in shape and usually flattened on one side and measures about 55x30µm.
- The adult worm is small, measuring 8 13 mm in length and white resembling a small piece of thread.

2) *Phthirus pubis*

- *Phthirus pubis* (pubic louse) may be found in urine as contamination or sexual contact.
- Lice are easily visible, being roughly 2 to 4 mm long. They have six legs armed with claws by which they attach to the skin. They have a short body and resembles a crab, and hence its nickname the crab louse.
- Nits are the eggs of the louse and are typically found attached to the hair shaft.
- They eggs are white and can be seen with the naked eye.

3) *Sarcoptes scabiei*

- *Sarcoptes scabiei* appear in urine as contamination, if infection occur in the sexual organs.
- The adult female is approximately 0.4 mm in length with a rounded body and eight short legs.
- The egg is oval about 0.1 0.15 mm in length.

Notes:

- Any of other parasites may be found in urine as faecal contamination especially in females.

Fig. 3.1d Trophozoites of *Trichomonas vaginalis* (400x).

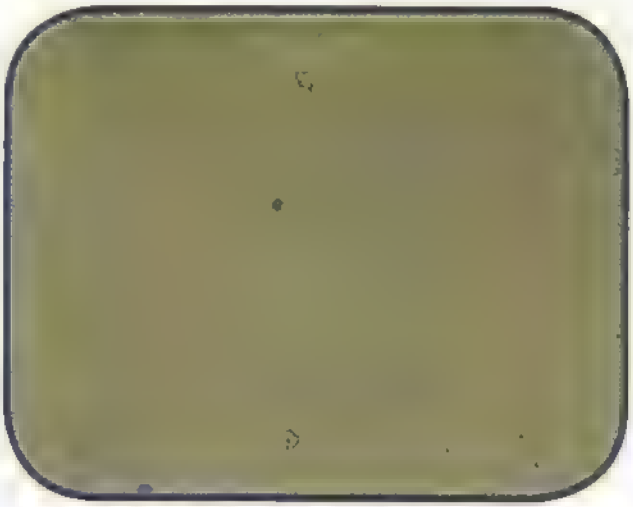


Fig. 3.2d Trophozoites of *Trichomonas vaginalis* (400x).

Fig. 3.3d Trophozoites of *Trichomonas vaginalis* (400x).

Fig. 3.4d. Trophozoite of *Trichomonas vaginalis* (400x).

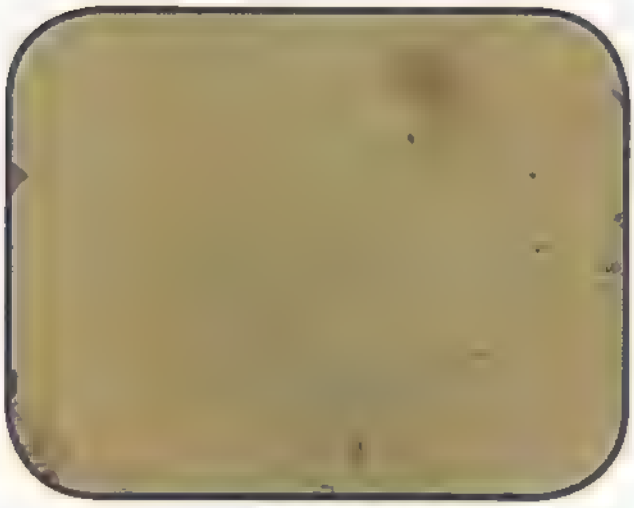


Fig. 3.5d Trophozoites of *Trichomonas vaginalis* (400x).

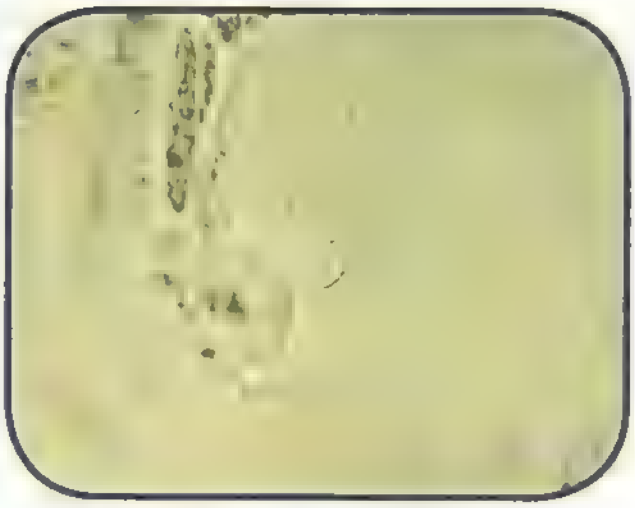


Fig. 3.6d: Trophozoites of *Trichomonas vaginalis* (400x).

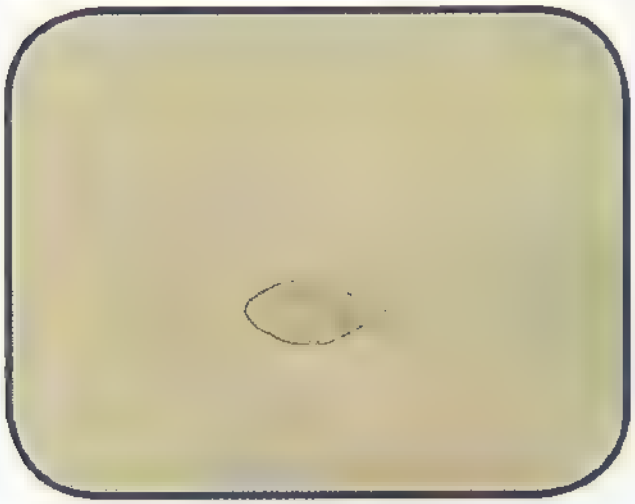


Fig. 3.7d: Ovum of *Schistosoma haematobium* (200x).

Fig. 3.8d: Ovum of *Schistosoma haematobium* (200x).

Fig. 3.9d: Ovum of *Schistosoma haematobium* (400x).

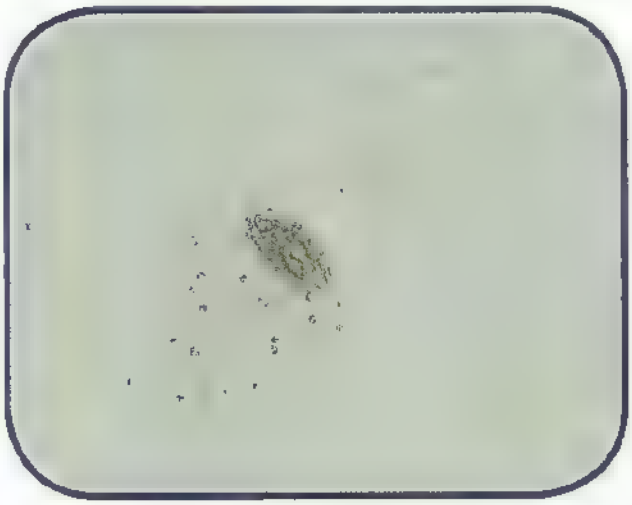


Fig. 3.10d: Ovum of *Schistosoma haematobium* and red blood cells (200x).

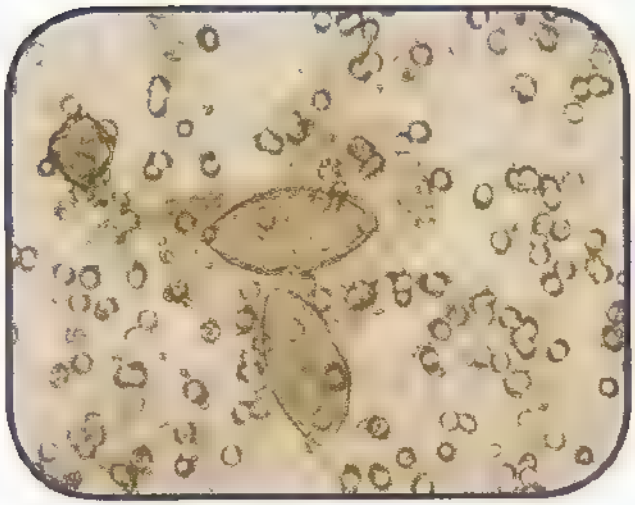


Fig. 3.11d: Two Ova of *Schistosoma haematobium* and red blood cells (400x).

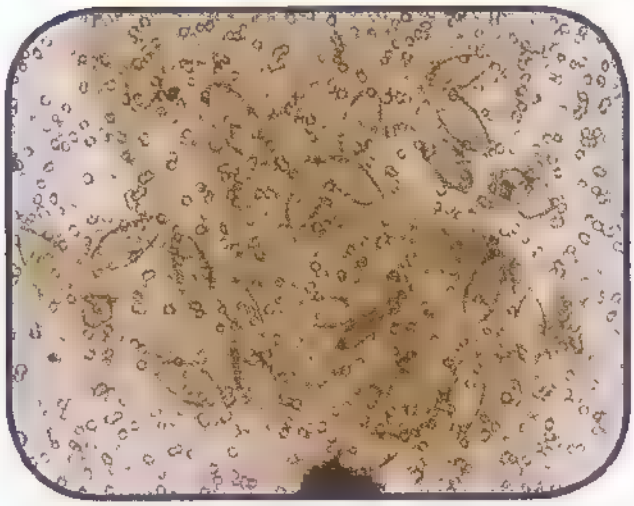


Fig. 3.12d: Ova of *Schistosoma haematobium* (100x).

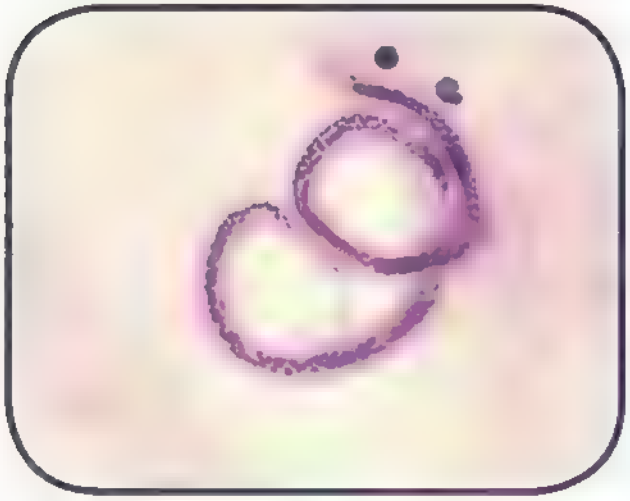


Fig. 3.13d Larva of *Wuchereria bancrofti* Giemsa stained film (400x).

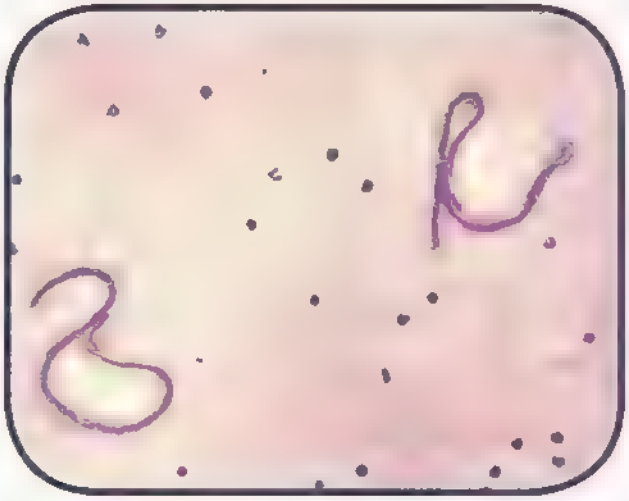


Fig. 3.14d Two Larvae of *Wuchereria bancrofti* Giemsa stained film (100x).

Fig. 3.15d Larva of *Onchocerca volvulus* Giemsa stained film (400x).

Fig. 3.16d Larva of *Wuchereria bancrofti* wet preparation(100x).

Fig. 3.17d Larva of *Onchocerca volvulus* wet preparation (200x).

Fig. 3.18d Larva of *Onchocerca volvulus* wet preparation (400x).

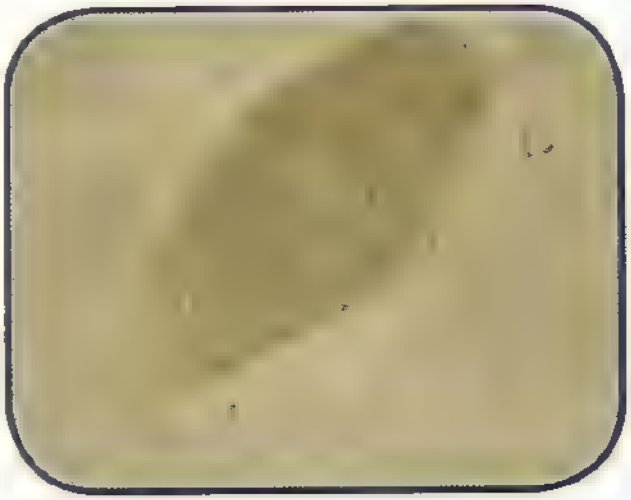


Fig. 3.19d: Ovum of *Schistosoma mansoni* with lateral spine (650x).

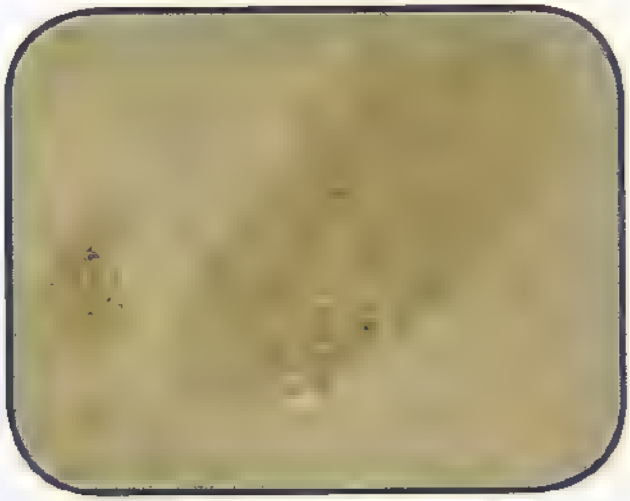


Fig. 3.20d: Ovum of *Schistosoma mansoni* (650x).

Fig. 3.21d: Ovum of *Schistosoma mansoni* (400x).

Fig. 3.22d: Ovum of *Schistosoma mansoni* (650x).

Fig. 3.23d. Ovum of *Schistosoma mansoni* (650x).

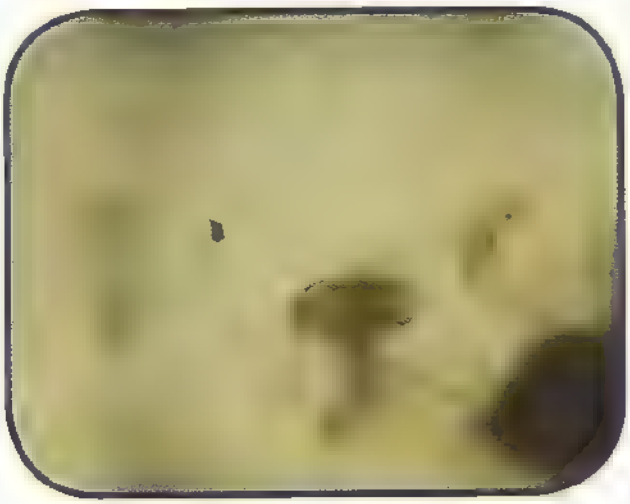


Fig. 3.24d: Ovum of *Schistosoma mansoni* (200x).

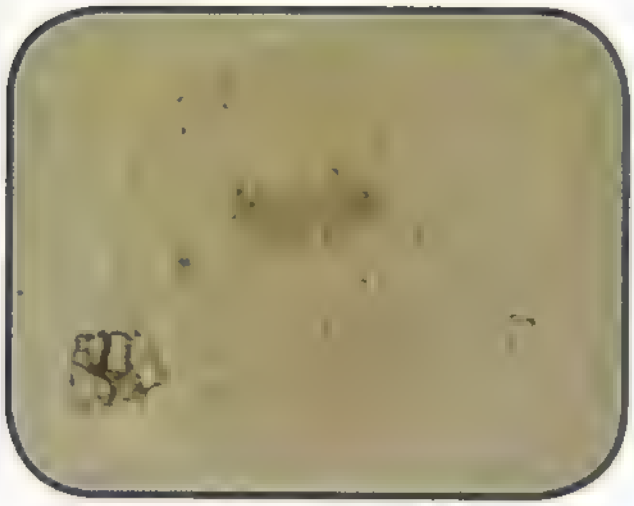


Fig. 3.25d: Hydatid sand (individual invaginated protoscolex) (650x).

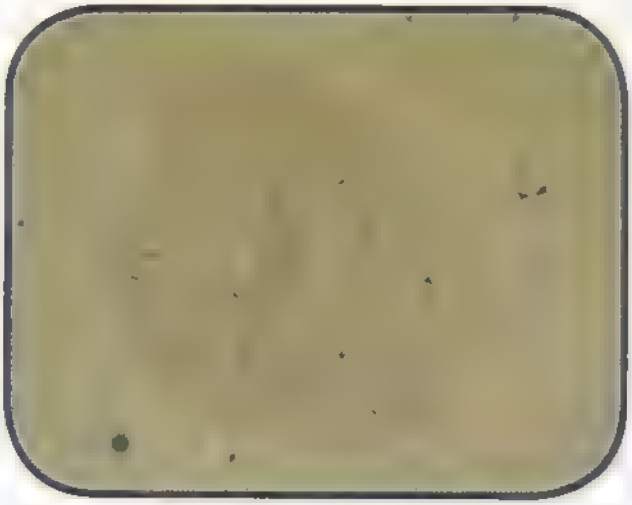


Fig. 3.26d: Hydatid sand (650x).

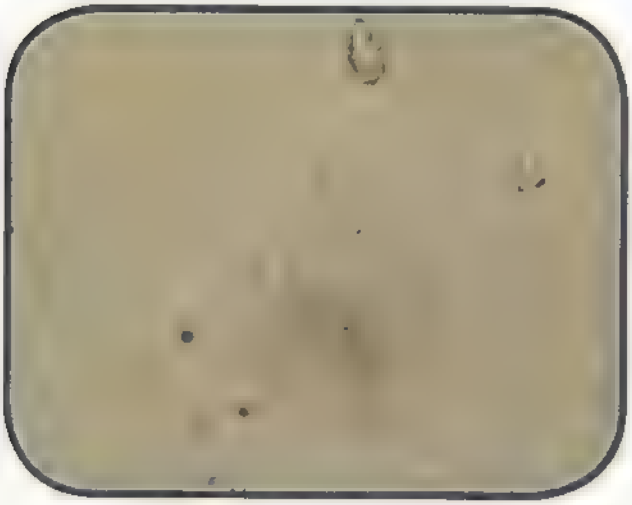


Fig. 3.27d: Hydatid sand (400x).

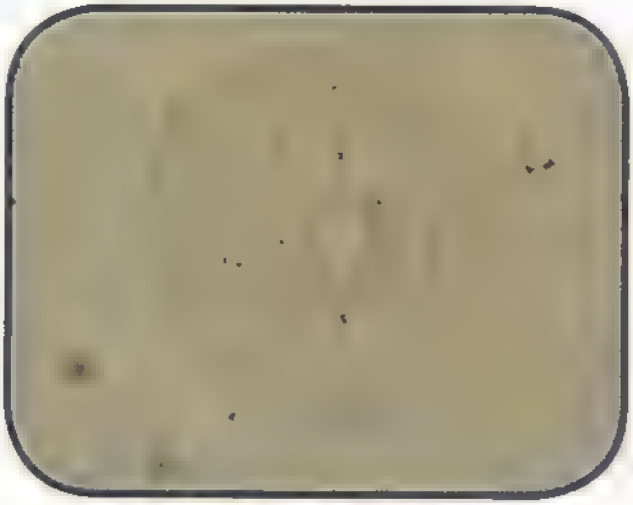


Fig. 3.28d: Hydatid sand (650x).

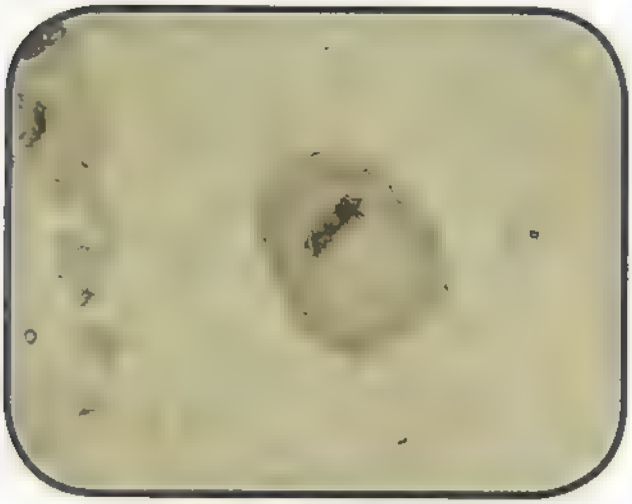


Fig. 3.29d: Hydatid sand (400x).

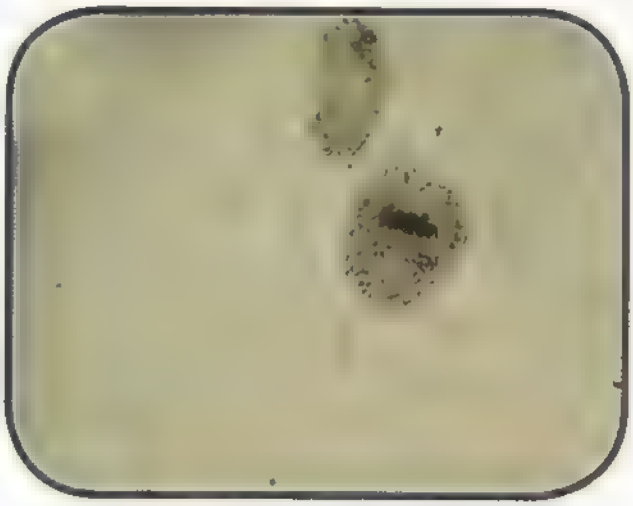


Fig. 3.30d: Hydatid sand (200x).

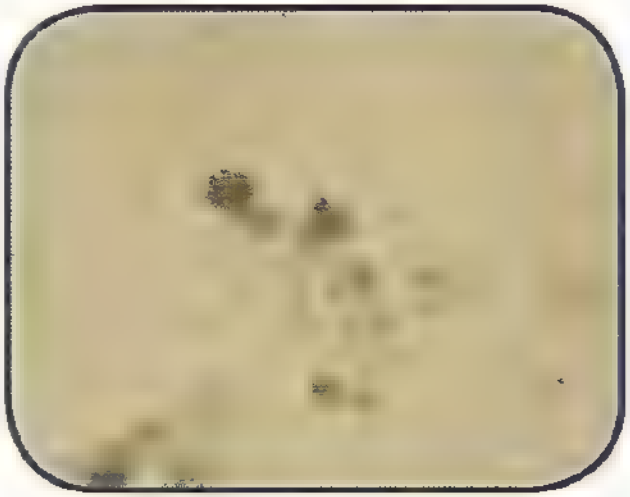


Fig. 3.31d: Ovum of *Entrobius vermicularis* (500x).

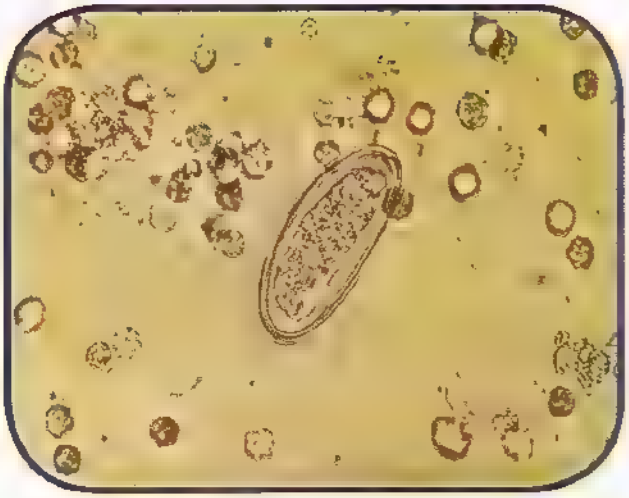


Fig. 3.32d: Ovum of *Entrobius vermicularis* and white blood cells (500x).

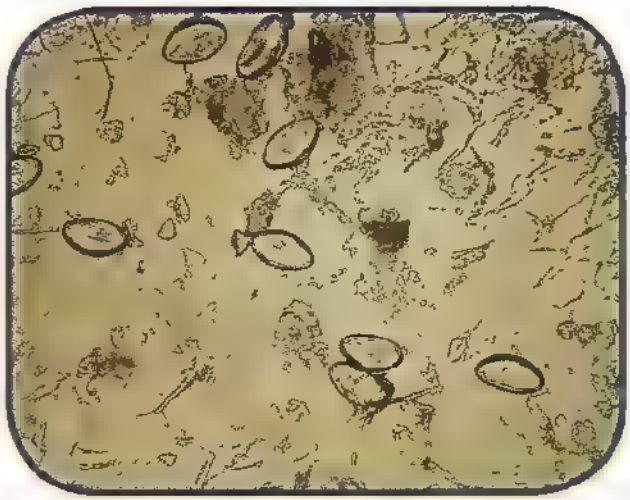


Fig. 3.33d: Ova of *Entrobius vermicularis* (250x).

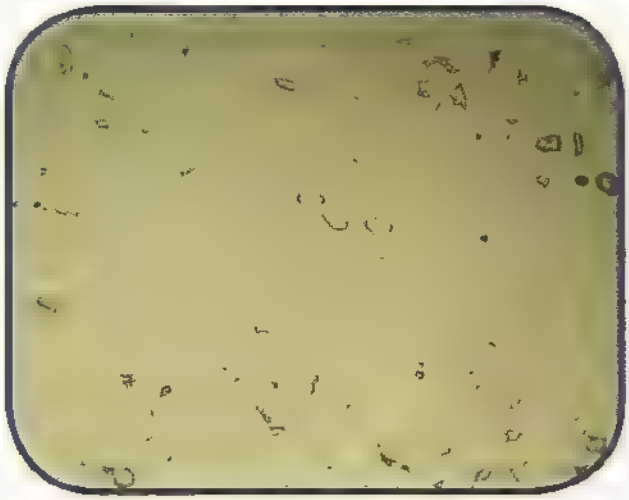


Fig. 3.34d: Ova of *Entrobius vermicularis* (100x).

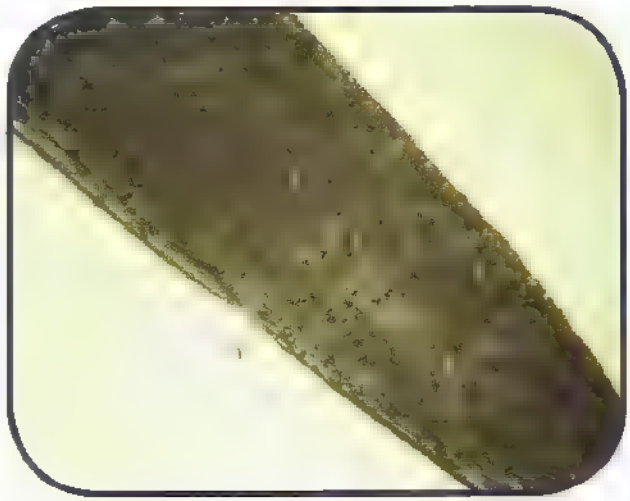


Fig. 3.35d: Adult female worm of *Entrobius vermicularis*. Notice the ova (500x).

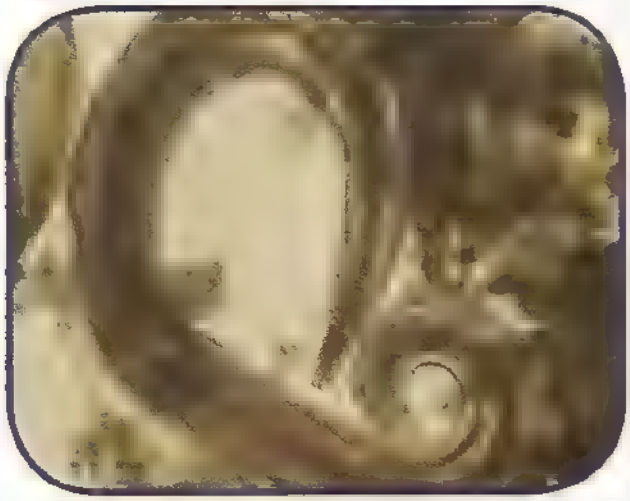


Fig. 3.36d: Adult male worm of *Entrobius vermicularis* (500x).

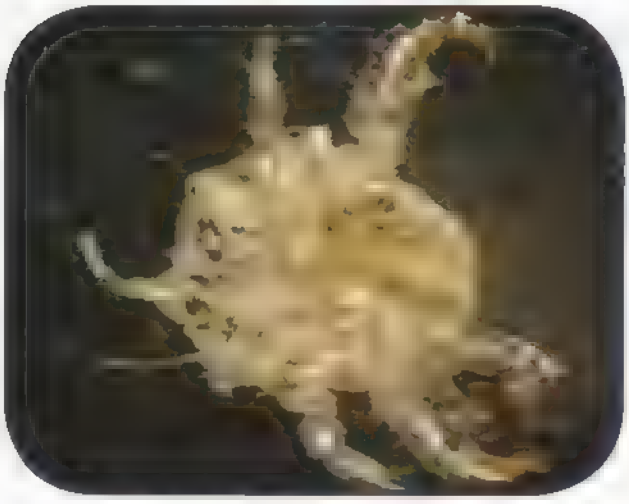


Fig. 3.37d: *Phthirus pubis*, the human "crab" louse (1000x).

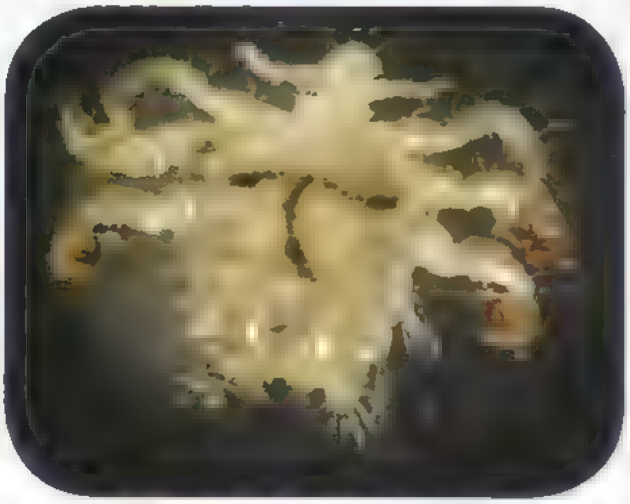


Fig. 3.38d: Adult female of *Phthirus pubis* (1000x).

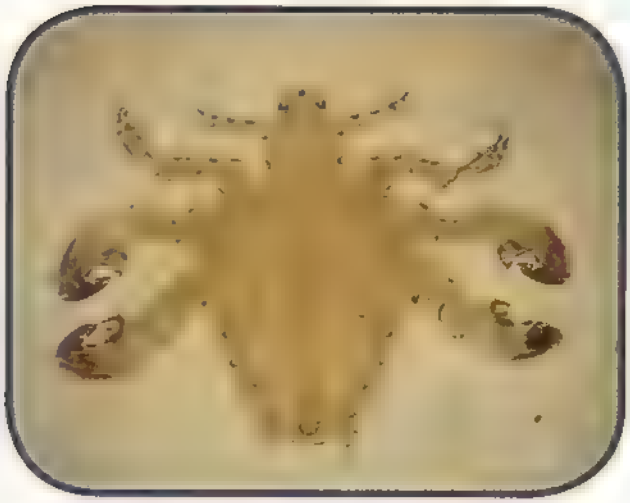


Fig. 3.39d: Adult male of *Phthirus pubis* (400x).

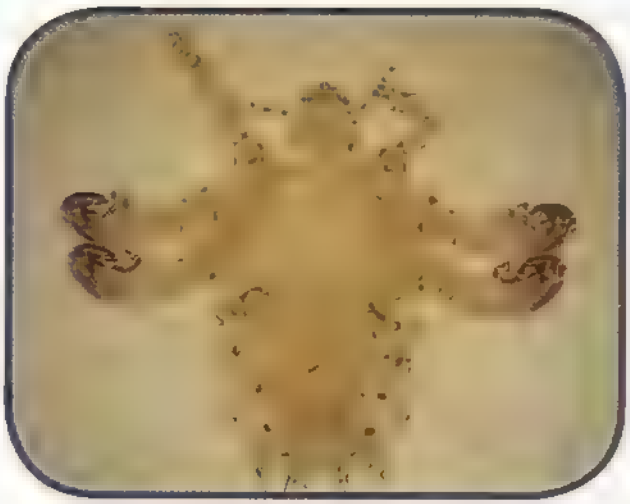


Fig. 3.40d: Adult female of *Phthirus pubis* (400x).

Fig. 3.41d: Adult female and egg of *Phthirus pubis* (400x).

Fig. 3.42d: Egg of *Phthirus pubis* attached to hair (400x).

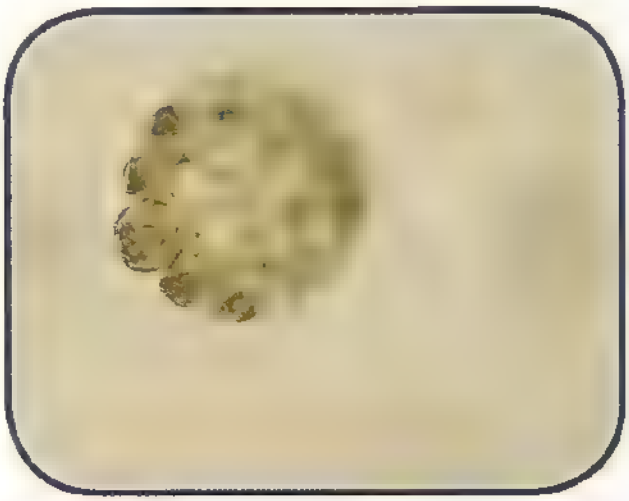


Fig. 3.43d: Adult of *Sarcoptes scabiei* (400x)

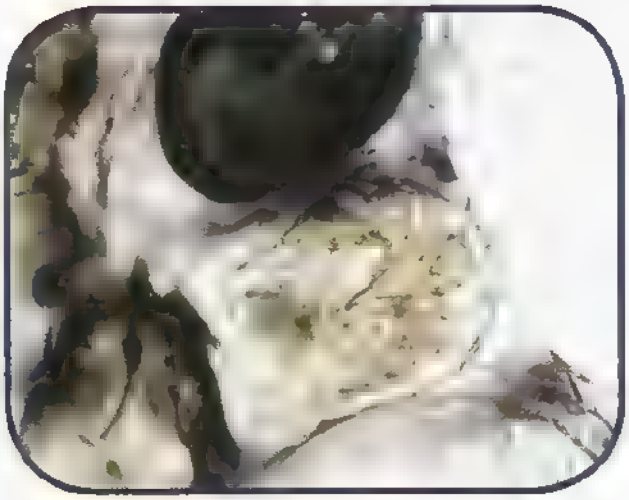


Fig. 3.44d: Adult of *Sarcoptes scabiei* (400x).

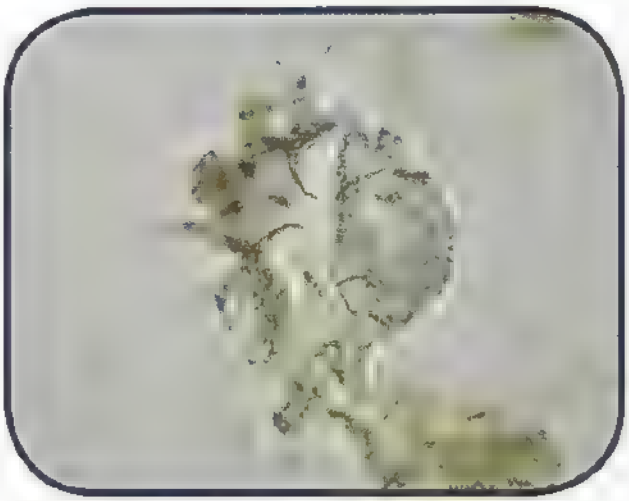


Fig. 3.45d: Adult of *Sarcoptes scabiei* (400x).

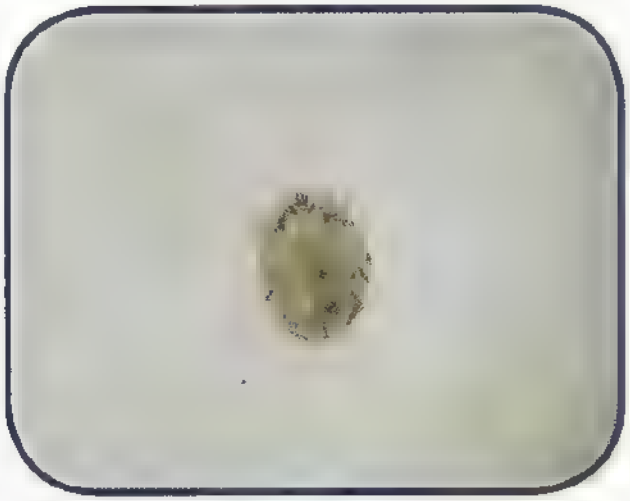


Fig. 3.46d: Adult of *Sarcoptes scabiei* (250x).

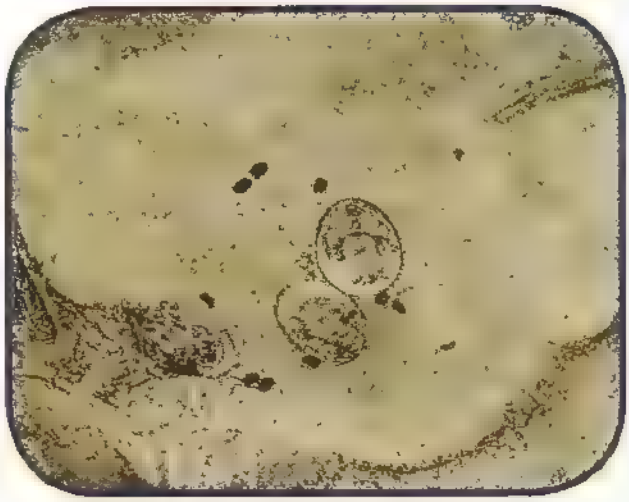


Fig. 3.47d: Eggs of *Sarcoptes scabiei* (250x).

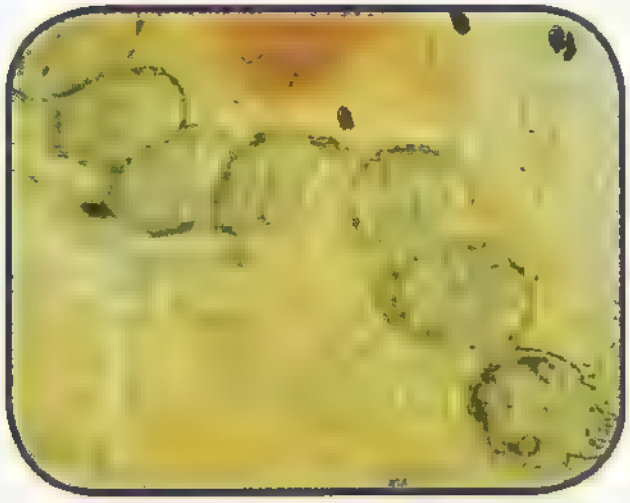


Fig. 3.48d: Eggs of *Sarcoptes scabiei* (250x).

Miscellaneous structures

Bacteria

- Bacteria are not normally present in urine.
- They are reported only when the urine is freshly passed and the presence of large number of WBCs.
- They may produce a positive nitrite test result.
- They are usually seen as rods, but sometimes cocci or streptococci.
- Bacteria may be misdiagnosed with amorphous material and calcium carbonate crystals.

Yeast cells

- Yeast cells appear in the urine as small, retractile oval structures that may or may not contain a bud.
- Buddying is usually helps to identify them as yeast cells . Pseudohyphae form Candida are occasionally found . A true yeast infection should be accompanied by the presence of WBCs. In severe infections, they may appear as branched, mycelial forms.
- The yeast cell is not lyse with acetic acid.
- Yeast cell may be misdiagnosed with red blood cells and starch granules .

Spermatozoa

- Spermatozoa are occasionally found in the urine of both men and women following sexual intercourse.
- They are also found in the urine of men following masturbation, or nocturnal emission.
- Spermatozoa are easily identified in the urine sediment by their oval, slightly tapered heads and long, flagella like tails and they may be motile in fresh urine.

Mucus

- Mucus threads are long, slender, transparent strands, which can occur normally in small numbers.
- Mucus appears microscopically as single or clumped thread-like structures.
- They are often twisted into various formations, and this characteristic aids in distinguishing them from casts.
- Mucus may be misdiagnosed with hyaline casts.

Cylindroid

- Cylindroids are composed of clear hyaline material and have ends which taper to slender, twisted, or curled tails and often irregular and striated and may contain fat globules.
- Cylindroid may be misdiagnosed with hyaline casts and mucus threads.

Fig. 3.1e: Long bacilli bacteria (400x).

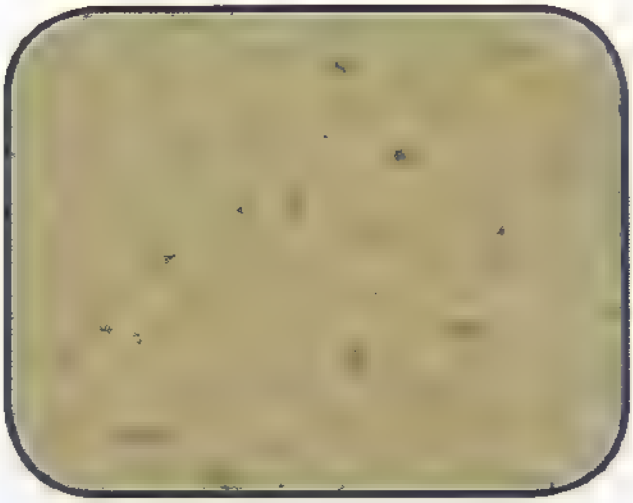


Fig. 3 2e: Bacteria (400x).

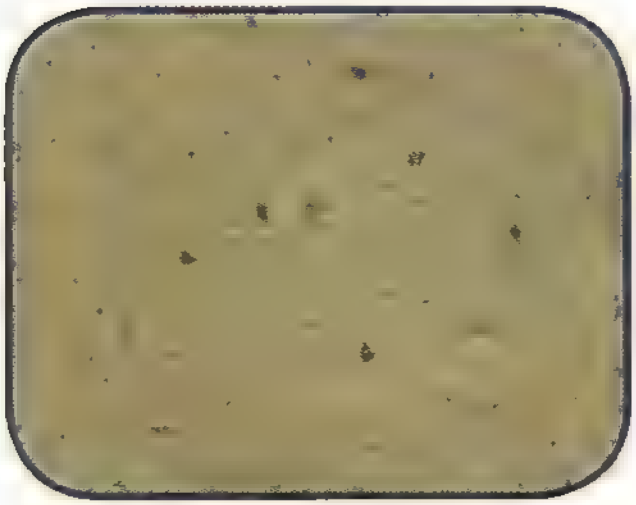


Fig. 3.3e: Bacteria (400x).

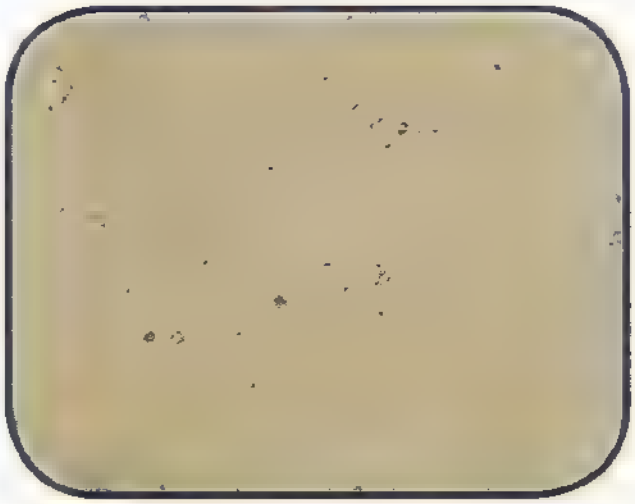


Fig. 3.4e: Bacteria and white blood cells (400x).

Fig. 3.5e: Cocci shaped bacteria (400x).

Fig. 3.6e: Bacteria and white blood cells (400x).

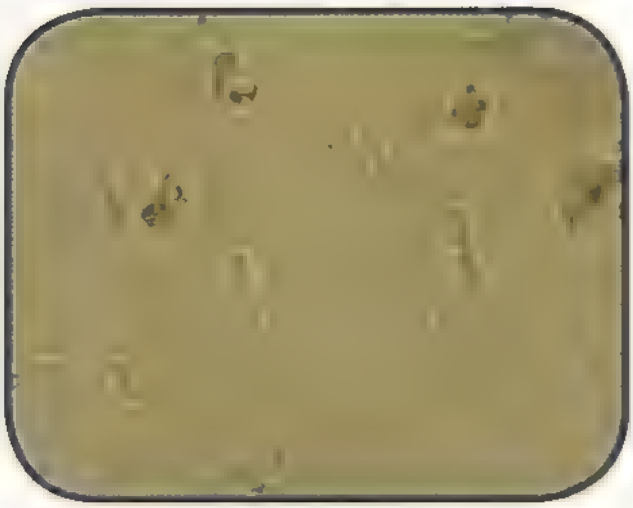


Fig. 3.7e: Yeast cells. Notice the budding (400x).

Fig. 3.8e: Budding yeast cells (400x).

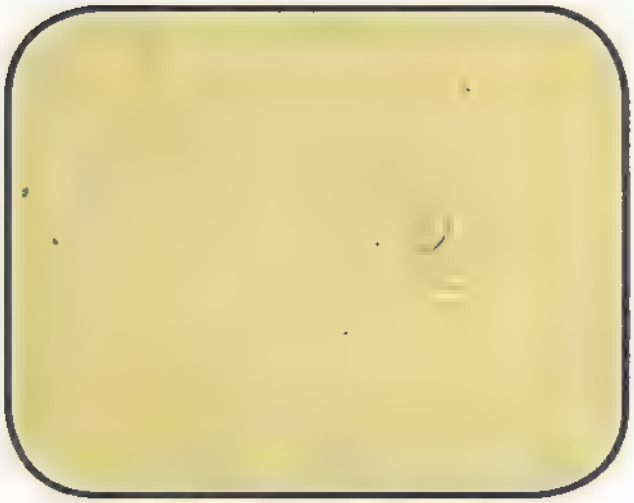


Fig. 3.9e: Yeast cells (400x).

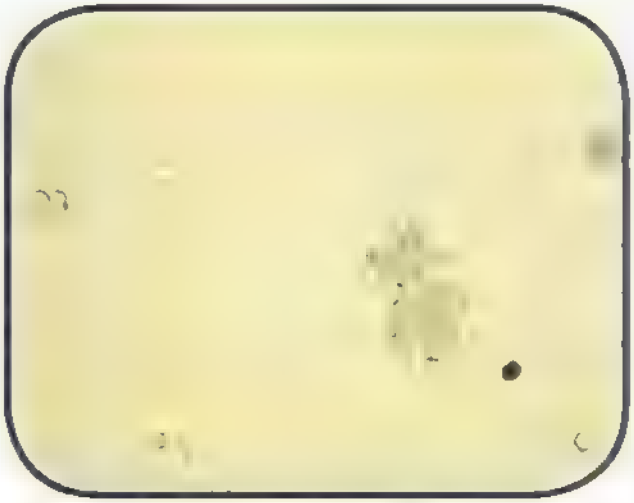


Fig. 3.10e: Clumped yeast cells (400x).

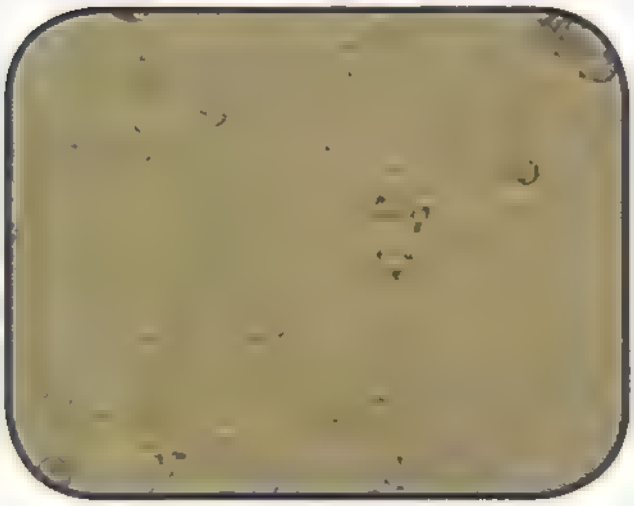


Fig. 3.11e: Yeast cells, pseudohypha and white blood cells (400x).

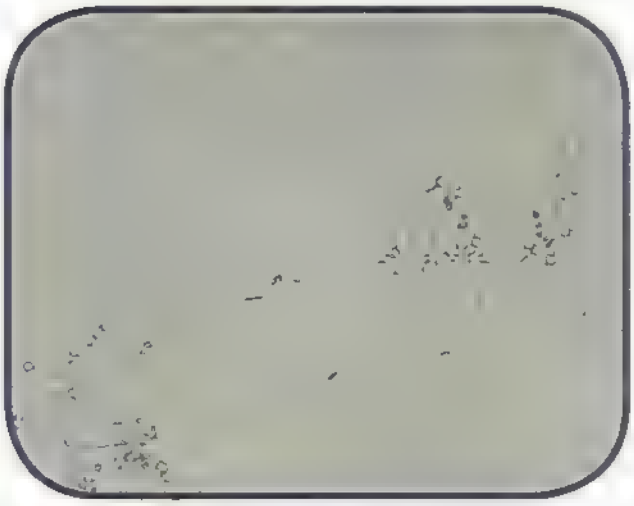


Fig. 3.12e: Pseudoyphae, yeast cells and epithelial cells (400x).

Fig. 3.13e: Spermatozoa (500x).

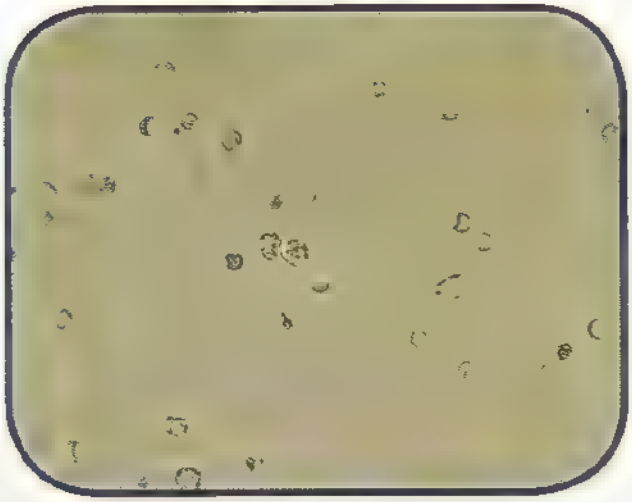


Fig. 3.14e Spermatozoa, red blood cells and white blood cells (400x).

Fig. 3.15e: Spermatozoa (400x).

Fig. 3.16e: Spermatozoa (400x).

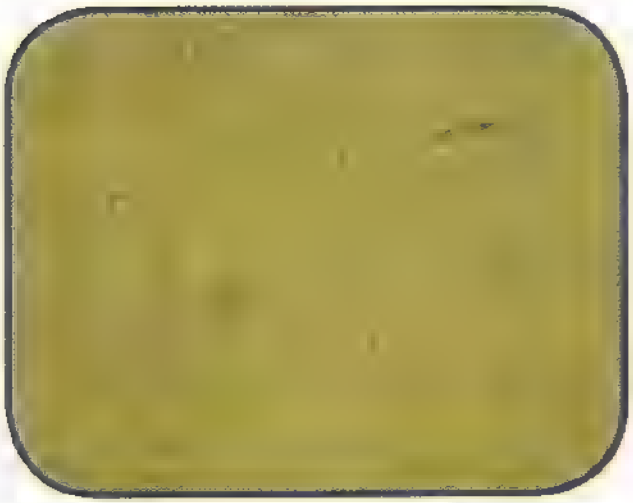


Fig. 3.17e: Spermatozoa (400x).

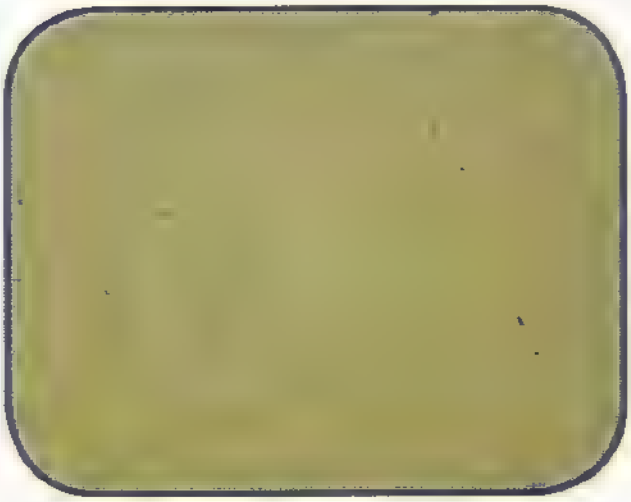


Fig. 3.18e: Spermatozoa (100x).

Fig. 3.19e: Mucus threads (400x).

Fig. 3.20e: Mucus threads (400x).

Fig. 3.21e: Mucus threads (400x).

Fig. 3.22e: Mucus threads (400x).

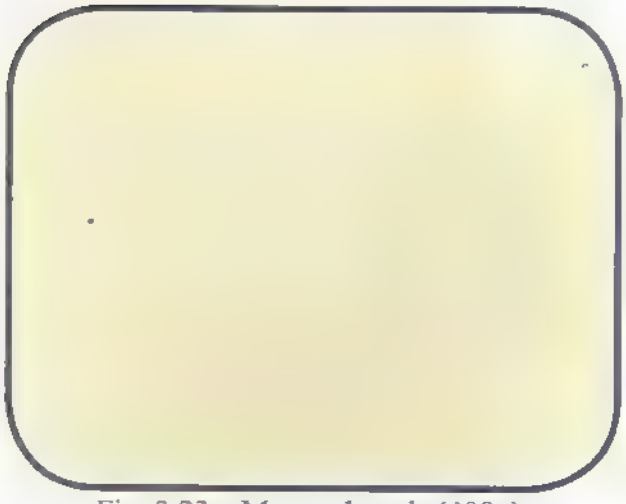


Fig. 3.23e: Mucus threads (400x).

Fig. 3.24e: Mucus threads (400x).

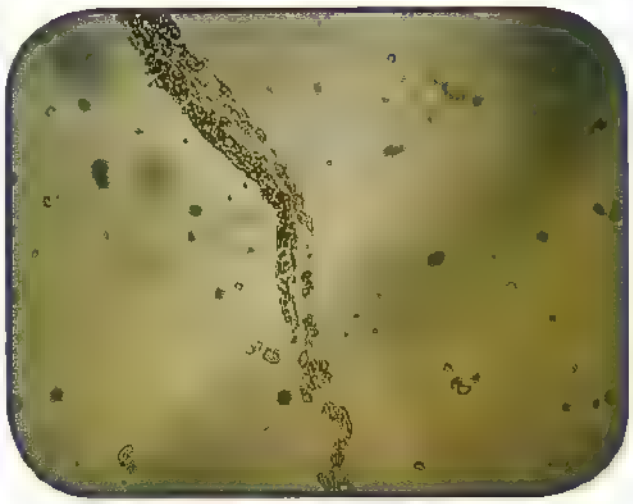


Fig. 3.25e: Cylindroid (400x).

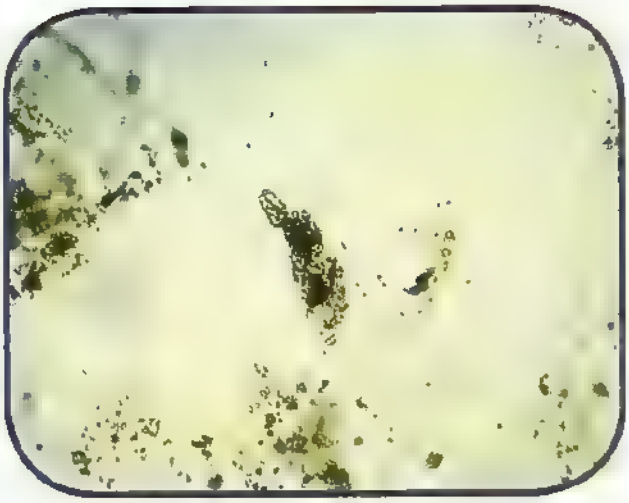


Fig. 3.26e: Cylindroid. Notice the tapering tail (400x).

Fig. 3.27e: Cylindroid and mucus threads (400x).

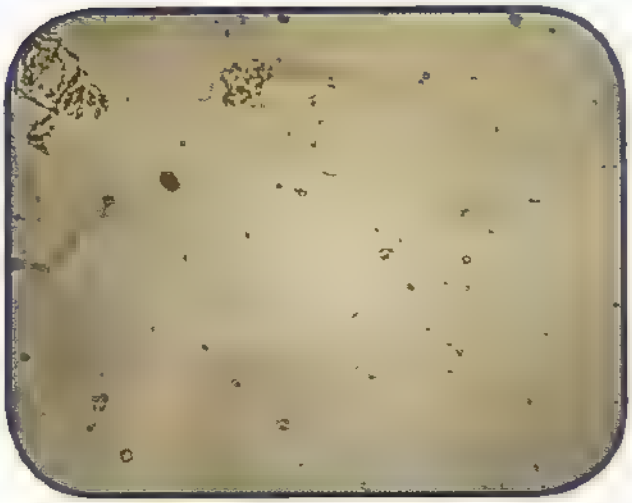


Fig. 3.28e: Cylindroid (400x).

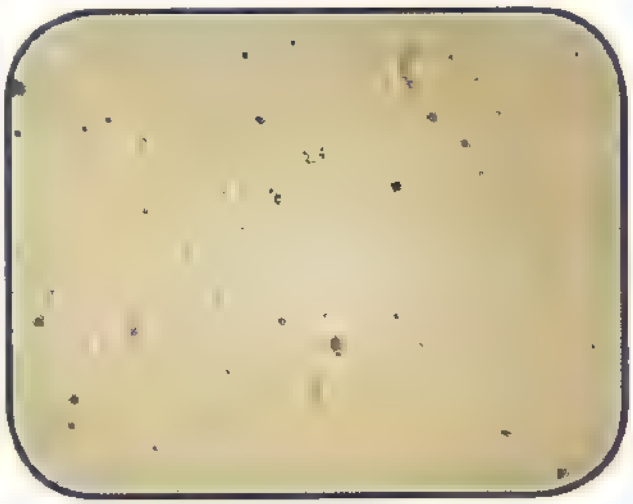


Fig. 3.29e: Cylindroid (250x).

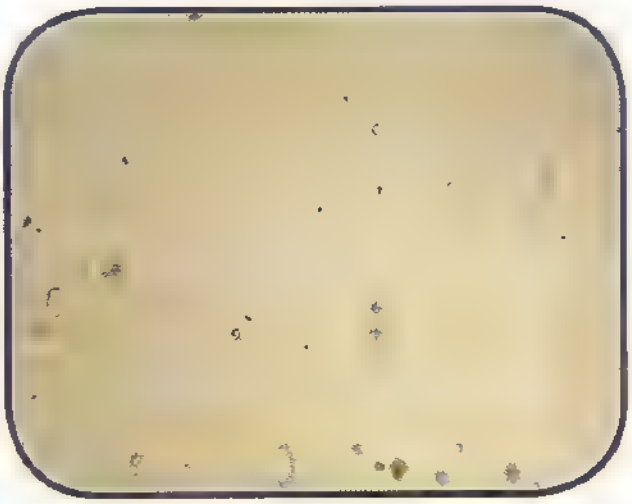


Fig. 3.30e: Cylindroid (400x).

Artifacts and contaminants in urine sediments

Artifacts and contaminants of all types can be found in urine, particularly in specimens collected under improper conditions or in dirty containers. The most frequently encountered artifacts and contaminants are:

1) Starch granules

- Starch granule contamination may occur when corn starch in the powder used in powdered gloves.
- The granules are highly refractile spheres and has characteristic central dimples.
- Starch granules may be misdiagnosed with yeast cells, so by adding a drop of iodine turn it blue black.

2) Pollen grains

- Pollen grains appear as spheres with a cell wall and occasional concentric circles.
- Like many artifacts, their large size may cause them to be out of focus with true sediment constituents.

3) Air bubbles

- Air bubbles are highly refractile and may resemble RBCs to inexperienced laboratory personnel
- They occur when the specimen is placed under a cover glass.

4) Cotton fibers

- Cotton fibers may come from clothing, diapers, toilet paper or lens paper, or they may be pieces of lint from the air.
- They are long and flat and easily recognizable. However, fibers those are short and are approximately the same size as casts can be mistaken for casts.

5) Oil droplets

- Oil droplets are highly refractile and may resemble RBCs to inexperienced laboratory personnel.
- They may appear in urine due to contamination by oil immersion or lotions or creams.

6) Fecal materials

- Fecal artifacts may appear in urine due to fecal contamination. They have a variety of sizes and shapes.

7) Hairs

- Hairs appear in urine as long sticks that may be misdiagnosed with larva of microfilariae.

8) Vegetable fibers

- Vegetable fibers are long with one pointed end and a central canal and they may have a regular spiral structure.
- They may be misdiagnosed with urine casts.

9) Glass fragments

- Glass fragments as well as scratches appear as crystals on the microscopic slide.
- Glass fragments may be misdiagnosed with urine crystals.

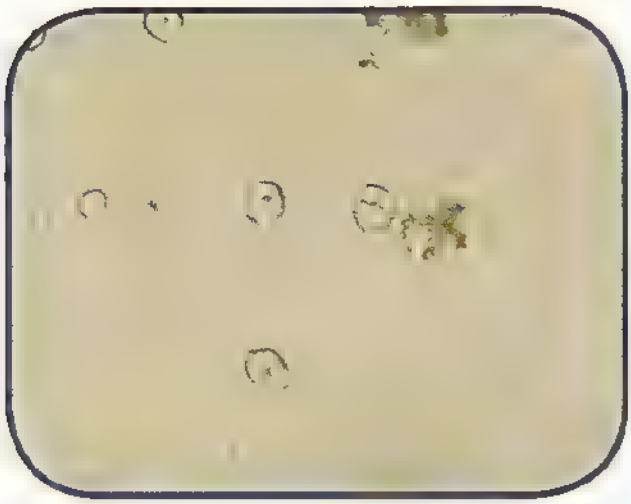


Fig. 3.1f: Starch granules. Notice the dimpled center (400x).

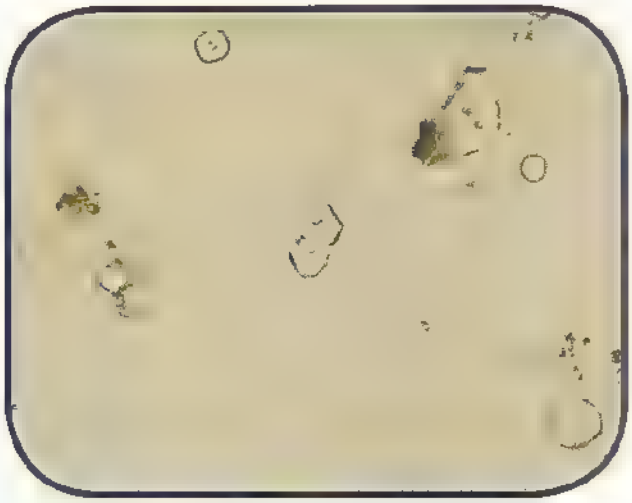


Fig. 3.2f: Starch granules (400x).

Fig. 3.3f: Starch granules (400x).

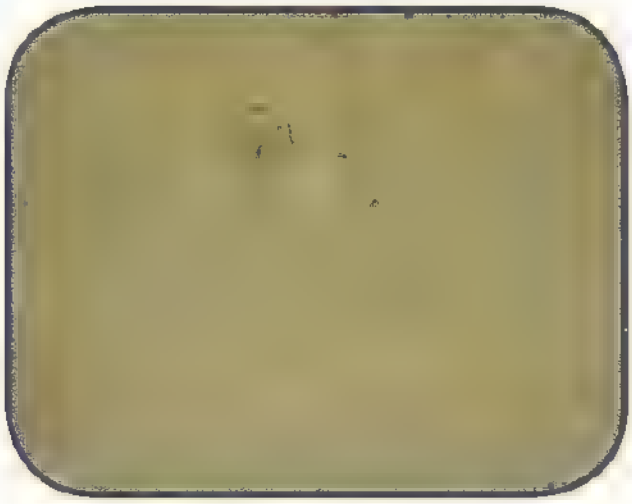


Fig. 3.4f: Starch granule (400x).

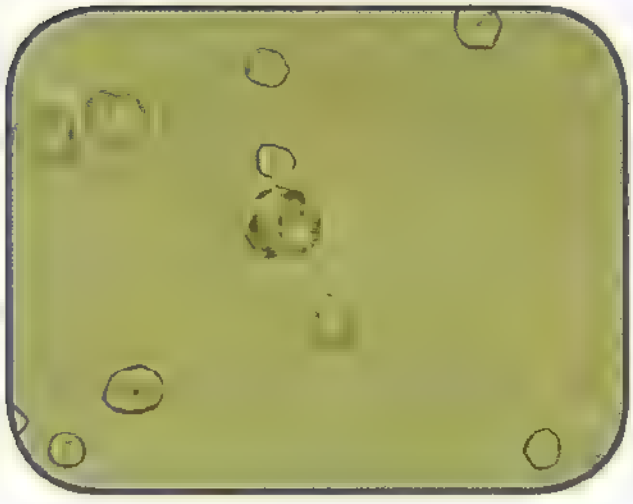


Fig. 3.5f: Starch granules (400x).

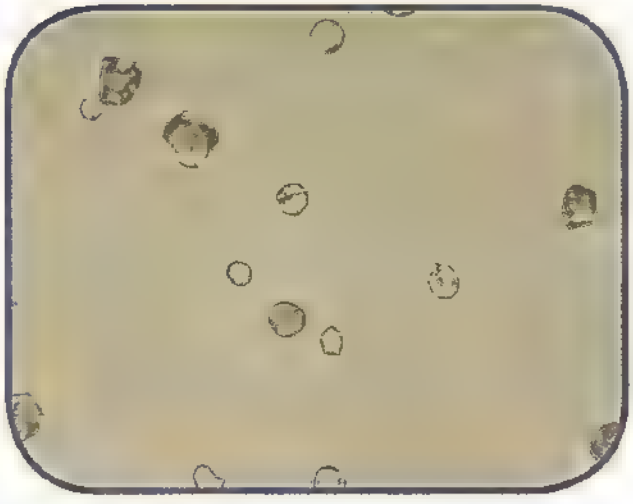


Fig. 3.6f: Starch granules (400x).

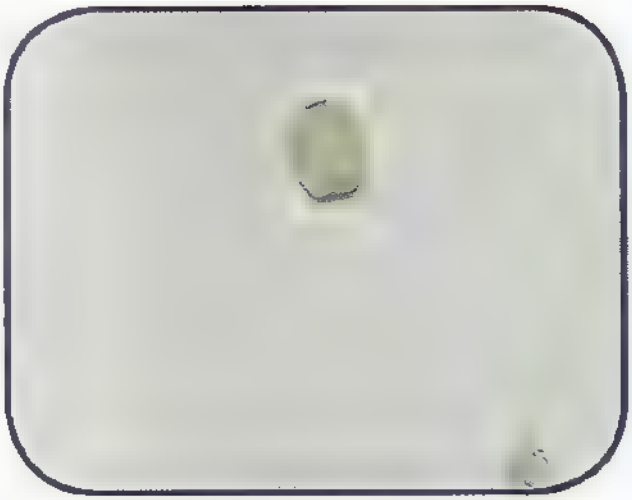


Fig. 3.7f: Pollen grain. Notice the concentric circles (400x).

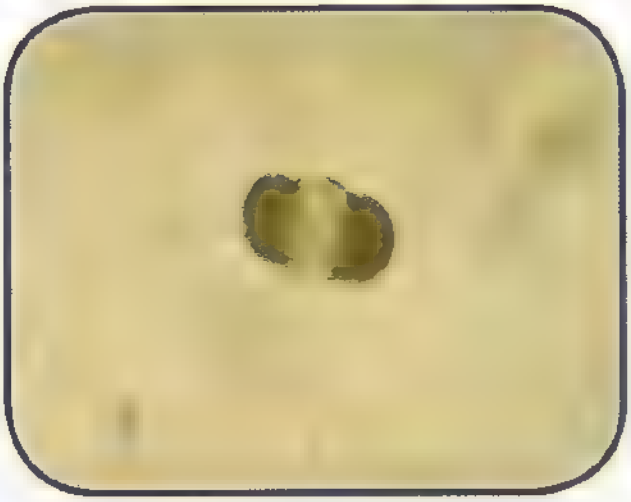


Fig. 3.8f: Pollen grain (400x).

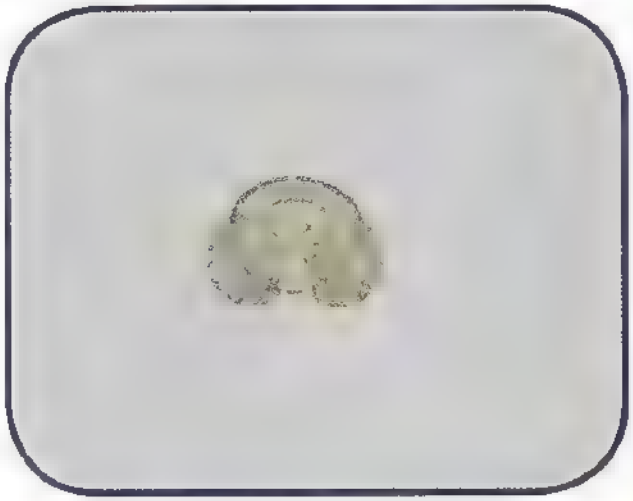


Fig. 3.9f: Pollen grain (400x).

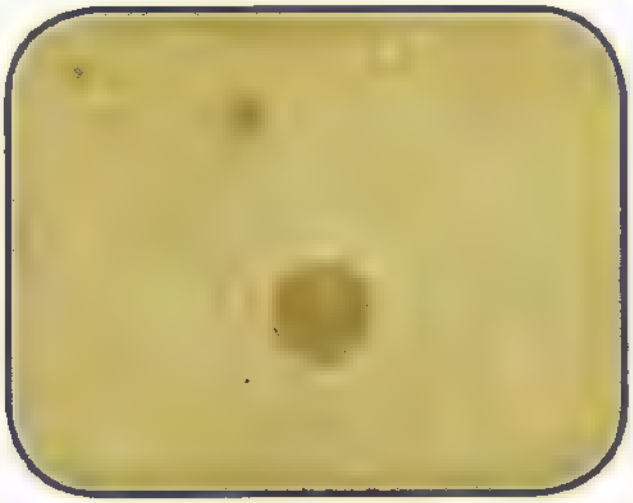


Fig. 3.10f: Pollen grain (400x).

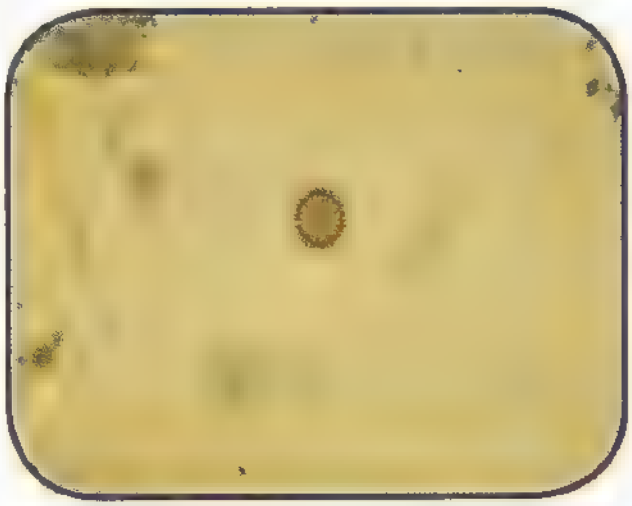


Fig. 3.11f: Pollen grain (400x).

Fig. 3.12f: Pollen grain (400x).

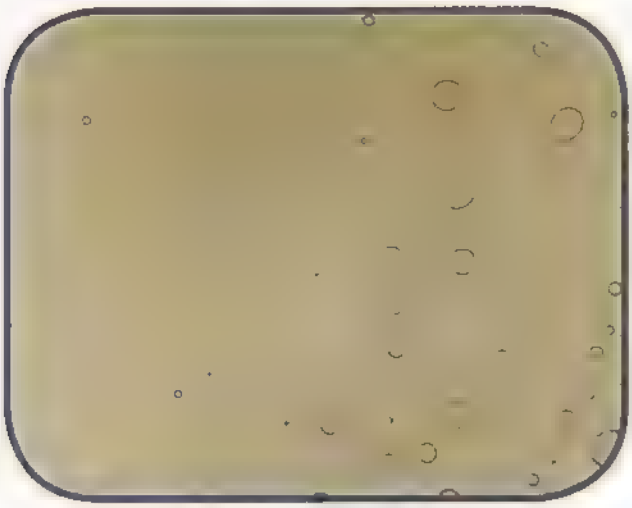


Fig. 3.13f: Air bubbles (100x).

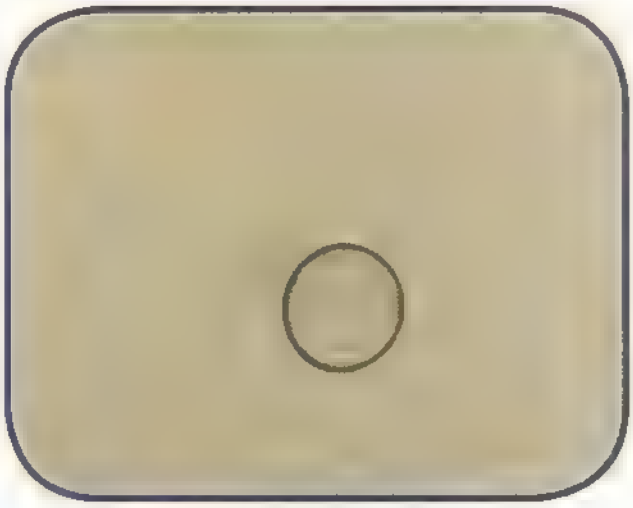


Fig. 3.14f: Air bubble (400x).

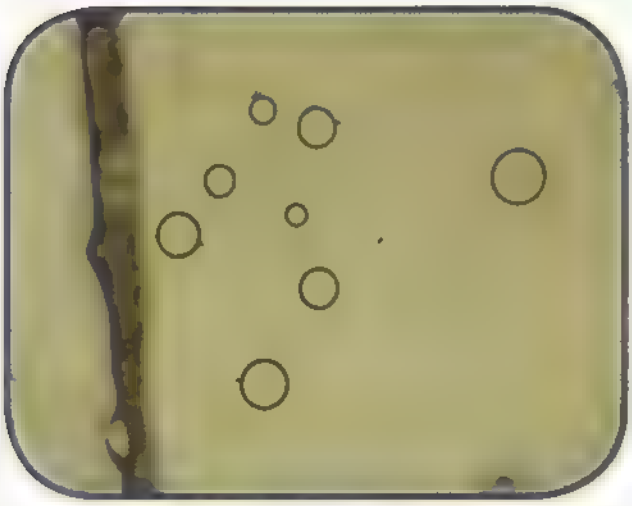


Fig. 3.15f: Air bubbles (400x).

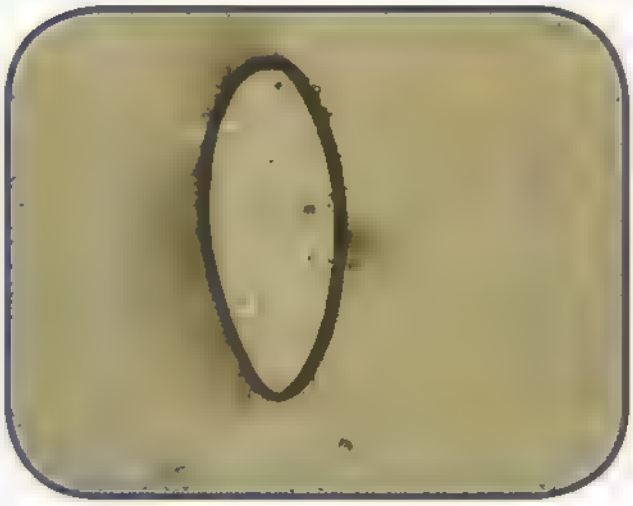


Fig. 3.16f: Large air bubble (400x).

Fig. 3.17f: Air bubble (400x).

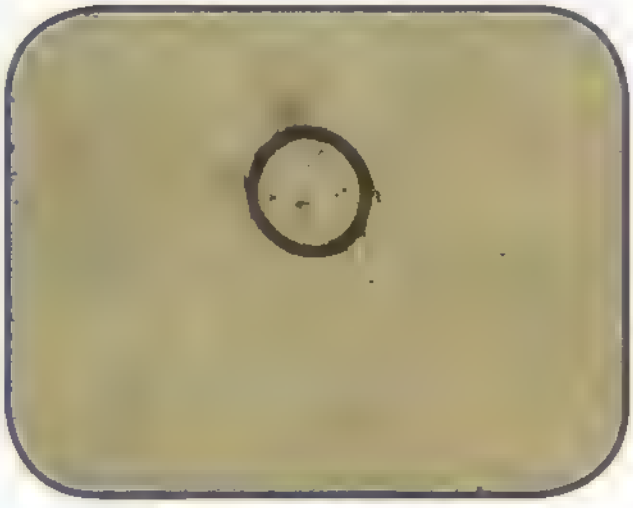


Fig. 3.18f: Air bubble (400x).

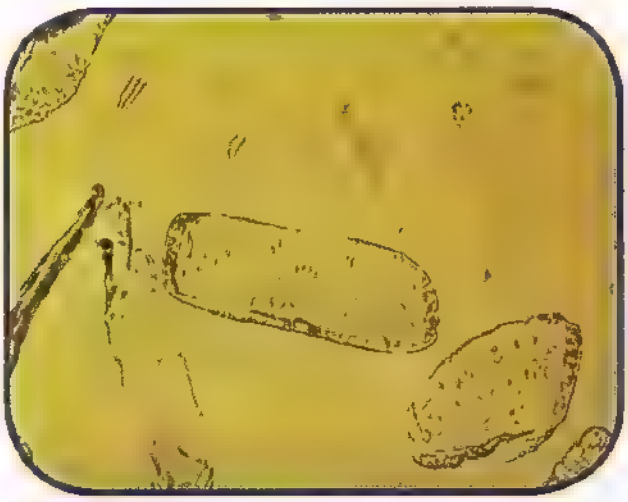


Fig. 3.19f: Cotton fibers resembling a cast (400x).

Fig. 3.20f: Cotton fiber (400x)

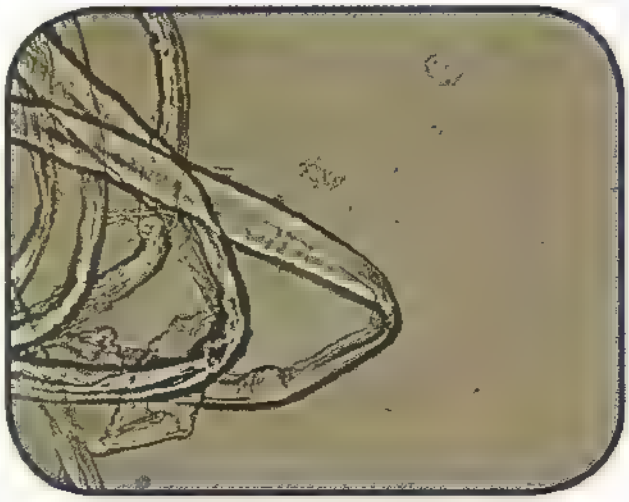


Fig. 3.21f: Cotton fibers (400x).

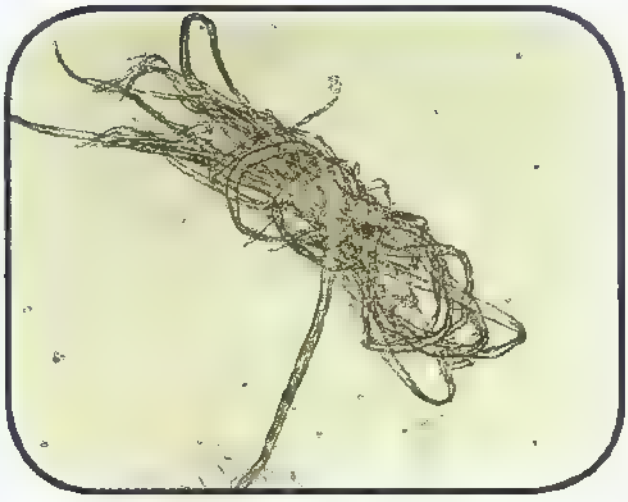


Fig. 3.22f: Cotton fibers (400x).

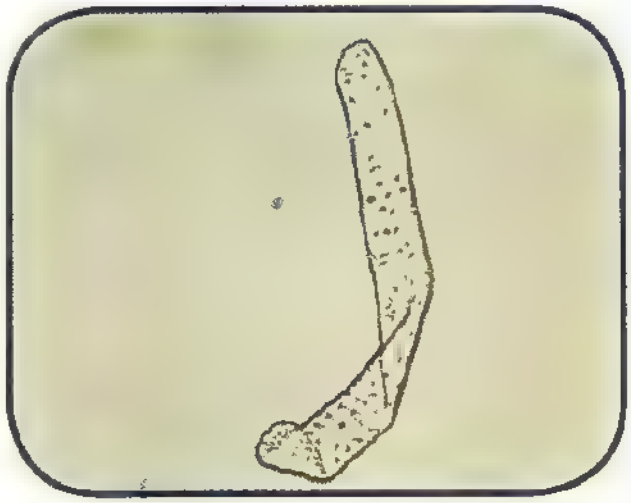


Fig 3.23f: Cotton fiber (400x).

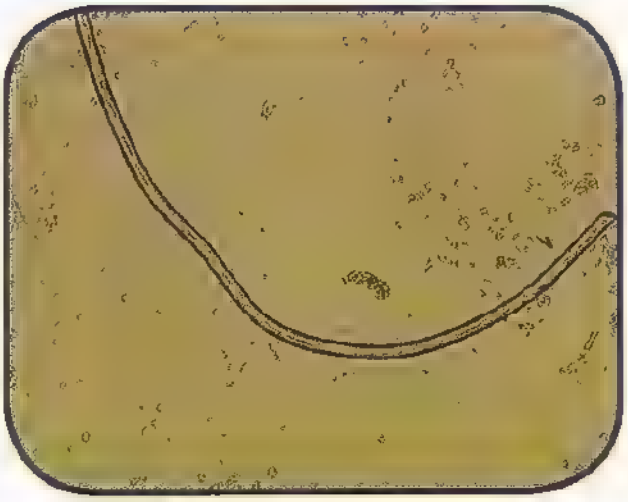


Fig. 3.24f: Cotton fiber (400x).

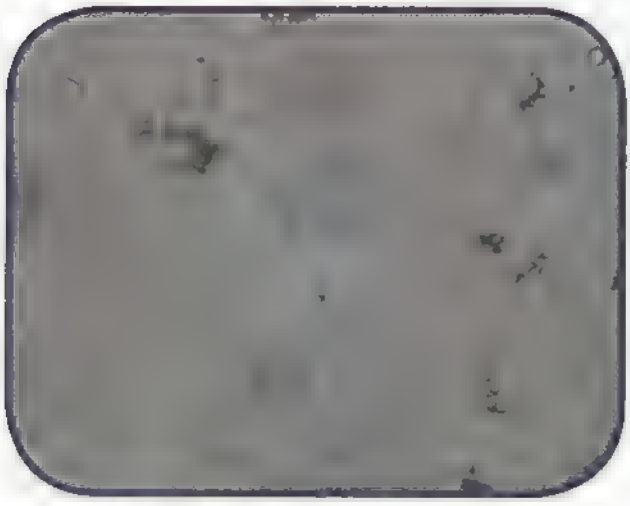


Fig. 3.25f: Oil droplets (400x).

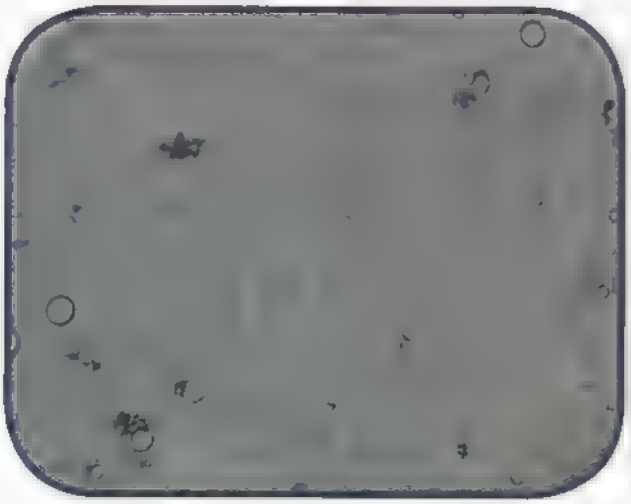


Fig. 3.26f: Oil droplets (400x).

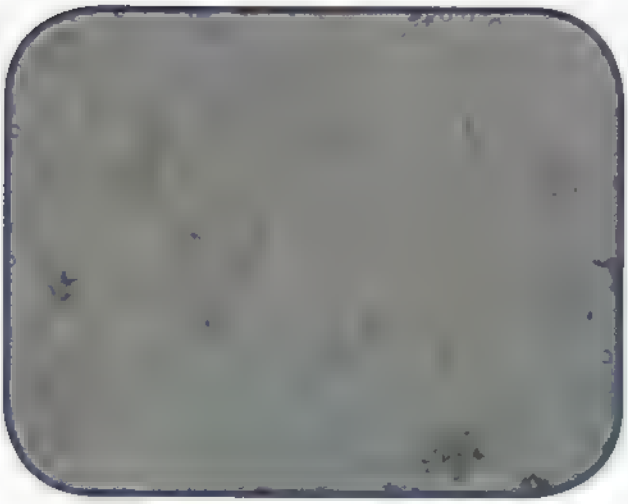


Fig. 3.27f: Oil droplets (400x).

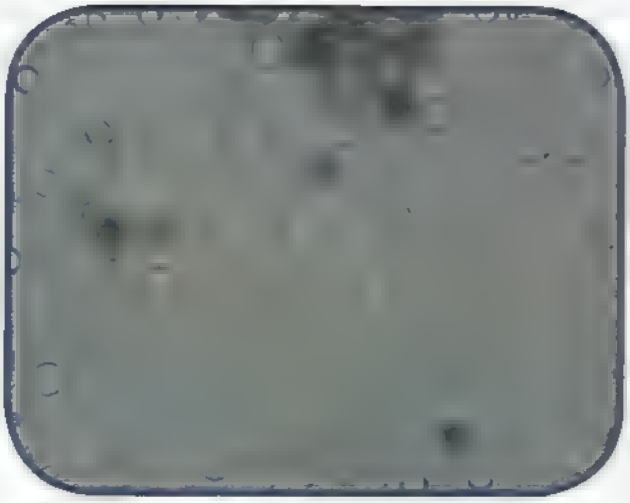


Fig. 3.28f: Oil droplets (400x).

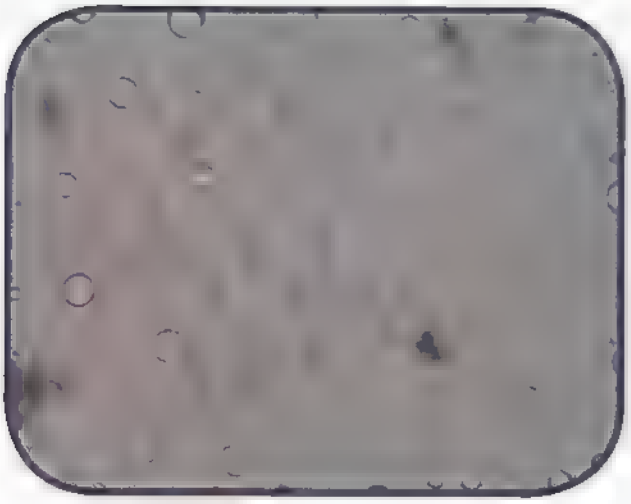


Fig. 3.29f: Oil droplets (400x).

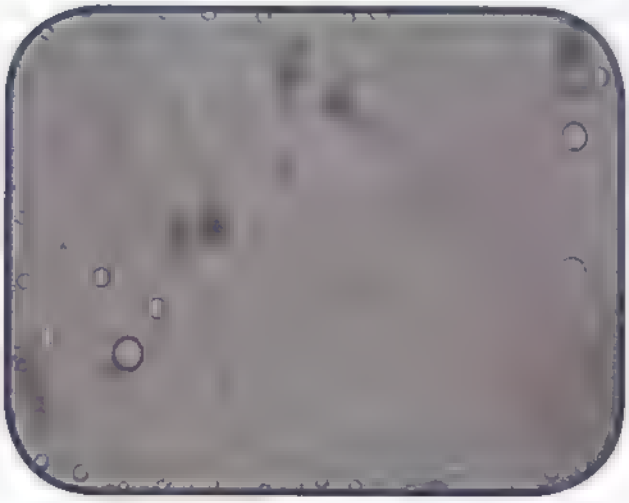


Fig. 3.30f: Oil droplets (100x).

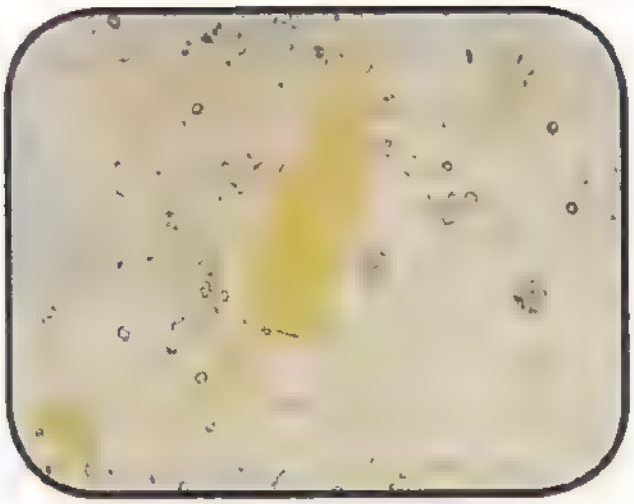


Fig. 3.31f: Fecal materials (400x).

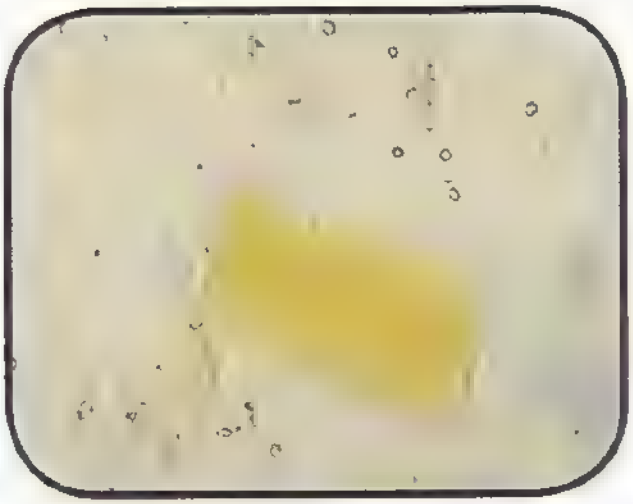


Fig. 3.32f: Fecal materials (400x).

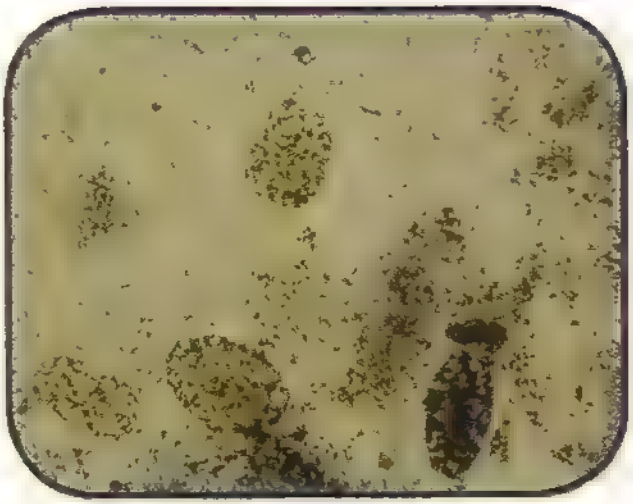


Fig. 3.33f: Fecal materials (400x).

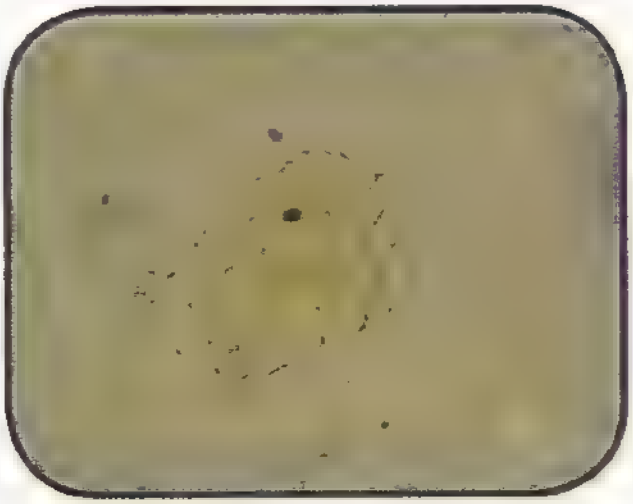


Fig. 3.34f: Fecal materials (400x).

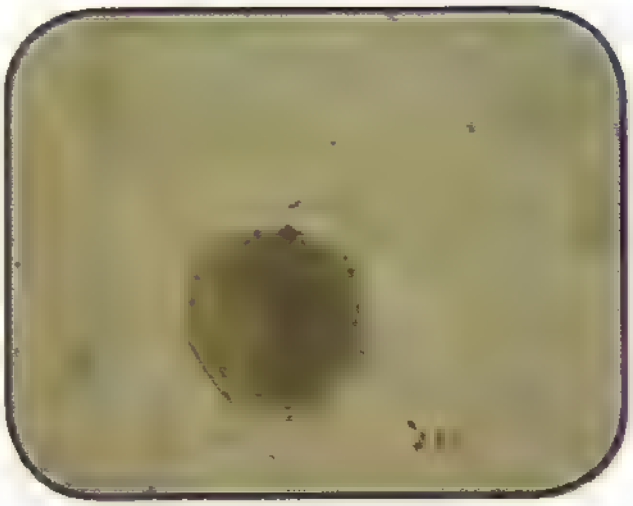


Fig. 3.35f: Fecal materials (400x).

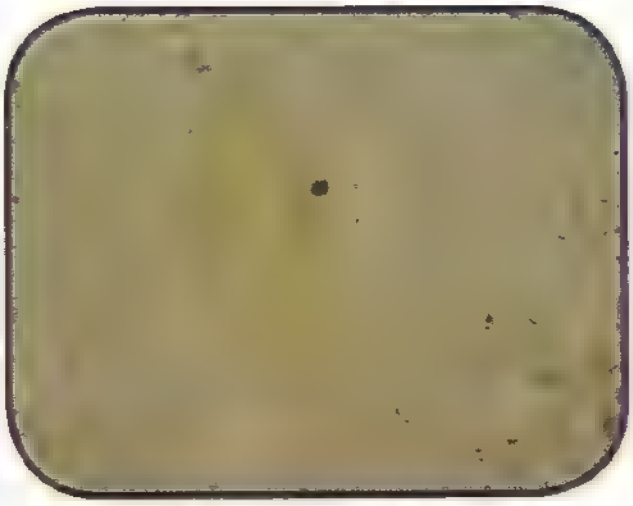


Fig. 3.36f: Fecal materials. Notice, they resemble the ovum of *S.haematobium* (400x).

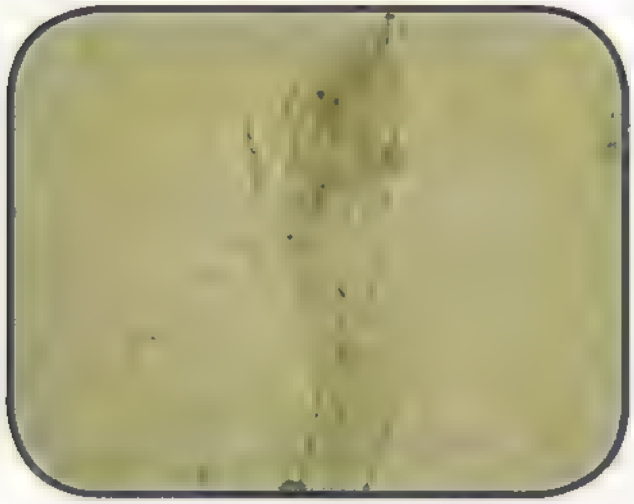


Fig. 3.37f: Hair (400x).

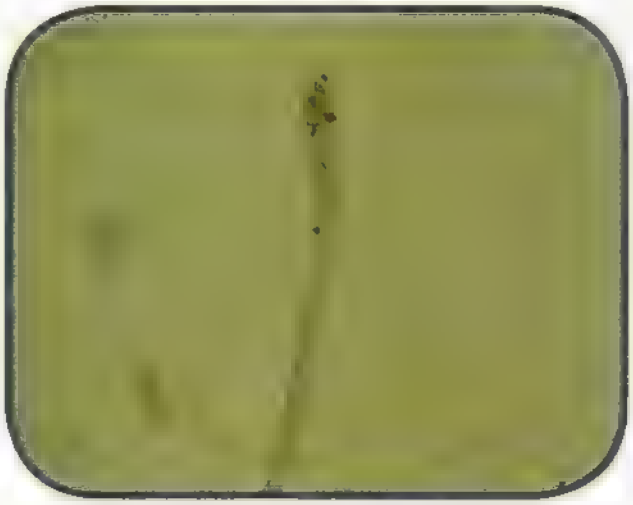


Fig. 3.38f: Hair (200x).

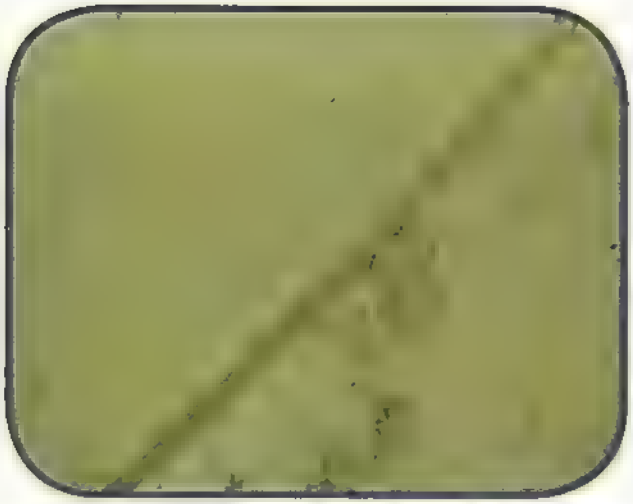


Fig. 3.39f: Hair (200x).

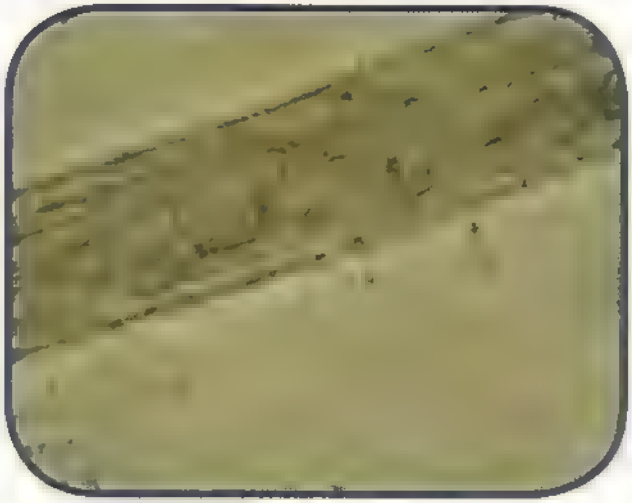


Fig. 3.40f: Hair (400x).

Fig. 3.41f: Hair (200x).

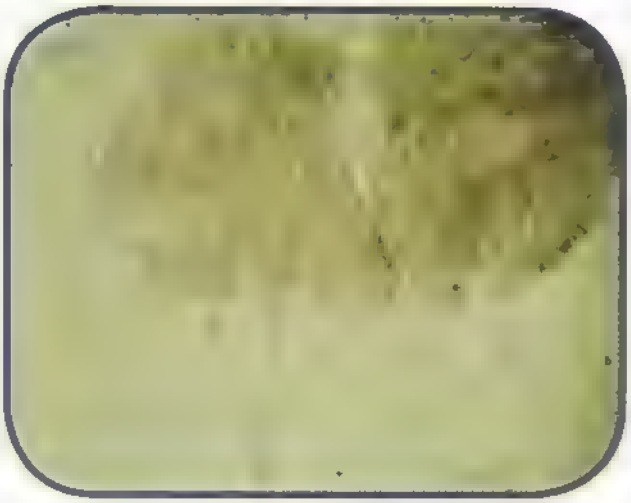


Fig. 3.42f: Hair (100x).

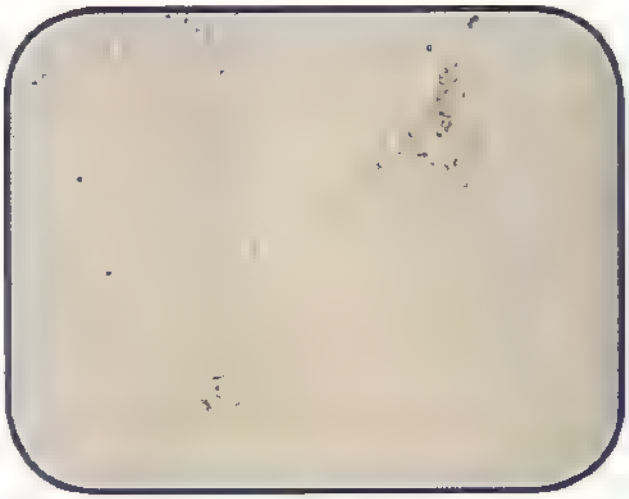


Fig. 3.43f: Vegetable fiber resembling waxy cast (400x).

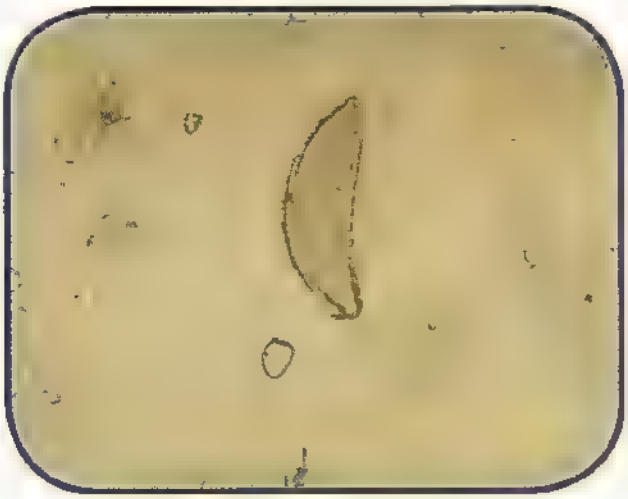


Fig. 3.44f: Vegetable fiber (400x).

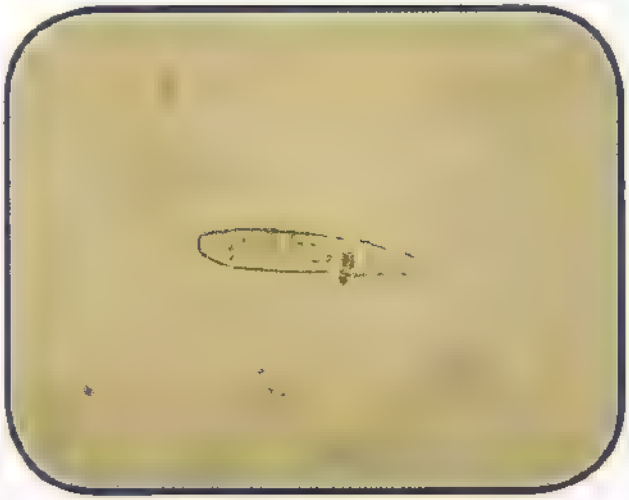


Fig. 3.45f: Vegetable fiber (400x).

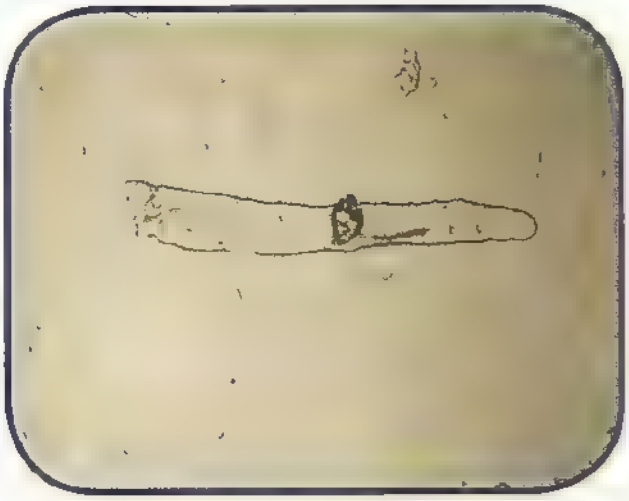


Fig. 3.46f: Vegetable fiber (400x)

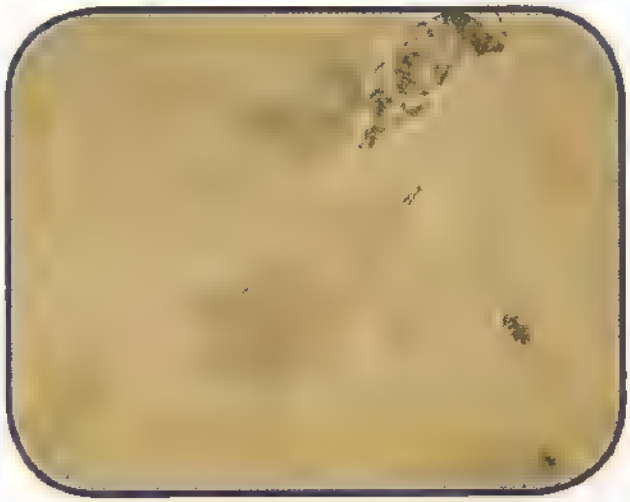


Fig. 3.47f: Vegetable fiber (400x).

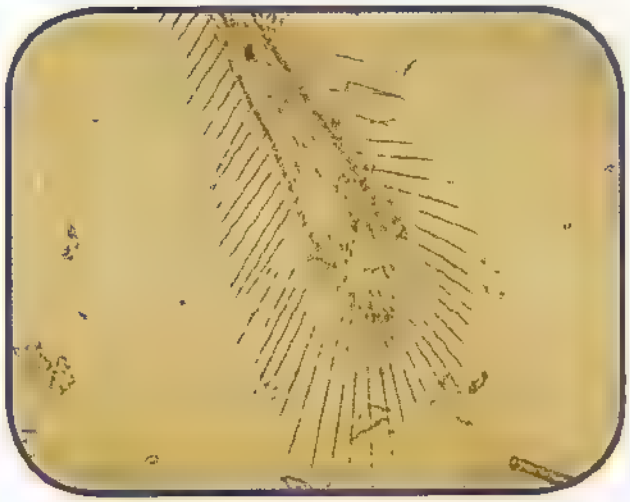


Fig. 3.48f: Vegetable fiber (400x).

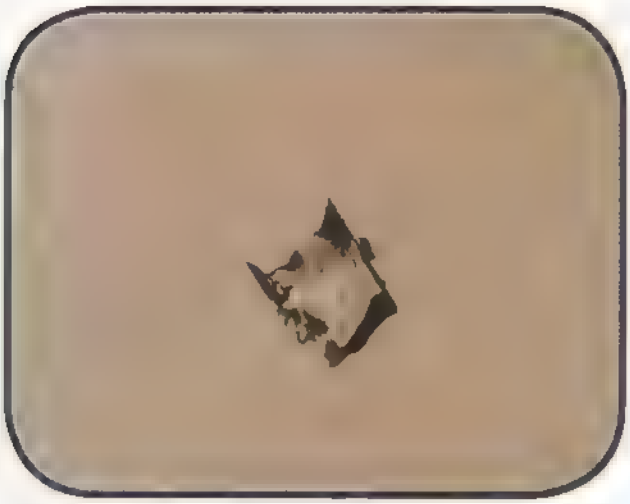


Fig. 3.49f: Glass fragment resembles the uric acid crystals (400x).

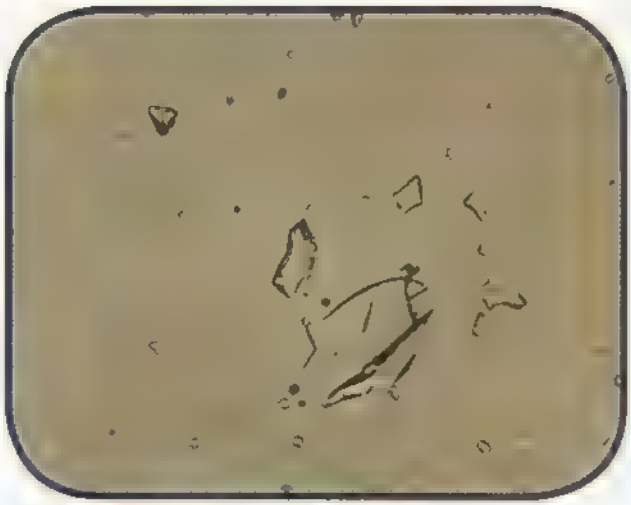


Fig. 3.50f: Glass fragments (400x).

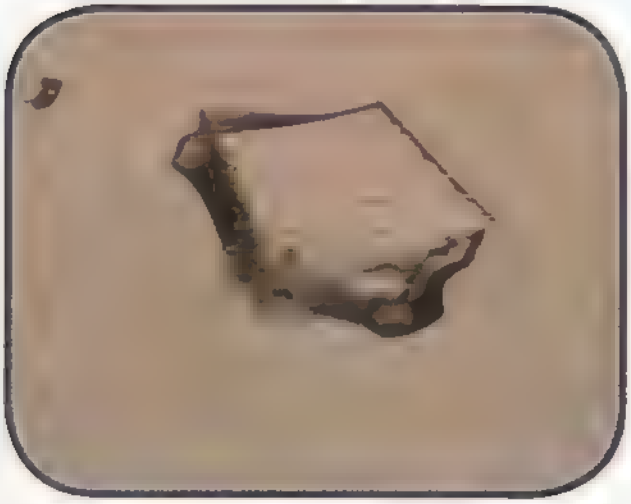


Fig. 3.51f: Glass fragments (400x).

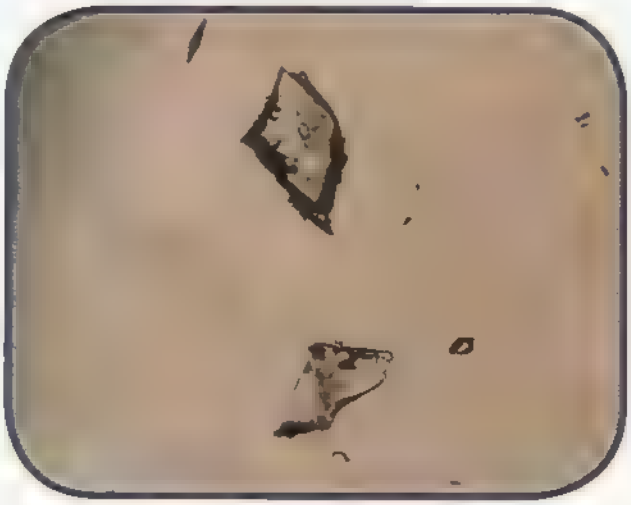


Fig. 3.52f: Glass fragments (400x).

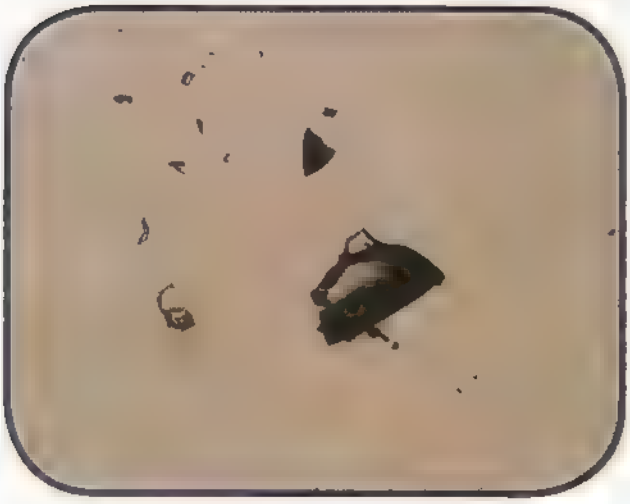


Fig. 3.53f: Glass fragments (400x).

Fig. 3.54f: Glass fragments (400x).

Reporting the Urine Sediments

Table 3.1: Reporting the urine sediments

Urine sediments	Report
Red blood cells	Few/ moderate/ many or average number per HPFs
White blood cells	Few/ moderate/ many or average number per HPFs
Squamous epithelial cells	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per LPF
Transitional epithelial cells	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per HPF
Renal tubular epithelial cells	Average number per HPF
Oval fat bodies	Average number per HPF
Casts	Average number per LPF
Crystals	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per LPF
Parasites	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per LPF
Bacteria	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per HPF
Yeast cells	Rare/few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per HPF
Spermatozoa	Few/ moderate/ many or 1+ , 2+ ,3+ ,4+ per HPF
Mucus	Scant/moderate/heavy or 1+ , 2+ ,3+ ,4+ per LPF
Cylindroid	Scant/moderate/heavy or 1+ , 2+ ,3+ ,4+ per LPF

Notes:

- Every person in the given laboratory who performs a microscopic examination should use the same terminology and reporting format.
- Spermatozoa are reported only in men.
- Artifacts and contaminants are not reported .
- High power field (HPF) mean 40x objective.
- Low power field (LPF) mean 10x objective.

Chapter IV

Automation of Urinalysis

Automation of Urinalysis

The advantages of automation of urinalysis are to save time, allow for standardization of procedures and reduces transcription errors.

Time-saving equipment and equipment that can accommodate large numbers of samples have been developed for every area of the clinical laboratory.

Automating laboratory procedures allow for better standardization of test performance and reduce not only the turnaround time but also transcription errors. Automated equipment for performing urine analysis takes the form of semiautomated or automated. Nearly each manufacturer of reagent strips has developed its own instrument. Some manufacturers have also developed automated systems for performing microscopic analysis on urine.

Several brands of urinalysis automation are currently available. The current choices available include strip readers, semiautomatic strip readers, fully automated urine chemistry analyzers, automated urine sediment analyzers, and completely automated urine analyzers with both chemical and sediment analysis capabilities.

Significant sediment findings may be missed if laboratory protocols direct laboratory personnel to skip microscopic evaluation when negative reagent strips findings are obtained. Crystals, renal tubular epithelial cells, parasites, and yeast do not have chemical indicators present on reagent strips currently in use. Semiautomated instruments require manual dipping of the reagent strip into the urine followed by placement on the instrument and identification of the specimen is keyed in prior to sampling of the specimen. Instruments that fully automate reagent strip reading use a barcode-labeled specimen. Although sampling is automated, tubes must still be decapped prior to placement on these instruments.

Automation of the microscopic portion of the urinalysis not only helps detect unexpected sediment but also helps standardize the identification and enumeration of urinary sediment.

Some instruments read the specimen's barcode, aspirates the sample, and performs urine sediment identification. The identification is done by enveloping a lamina of the sample with a suspension fluid that moves past the objective lens of the microscope. A digital camera, illuminated by a strobe lamp, captures 500 frames per sample. The Auto-Particle Recognition software uses size, shape, contrast, and texture to classify images. Digital images are reviewed by a technologist and correlated to chemical and physical findings prior to reporting. Electronic archiving of results allows results to be reviewed by multiple users for confirmation of results, quality control, or used in training sessions.

However, there some disadvantage in automation of urinalysis as negative strip reading may mean significant, microscopic findings will be overlooked and the instrument is expensive.

Fig. 4.1: Iris Diagnostics Division iQ®200 Automated Urinalysis System (AUTION plus iQ®200).

Fig. 4.2: Siemens Medical Solutions Diagnostics manufacturesthe Clinitek® Atlas.

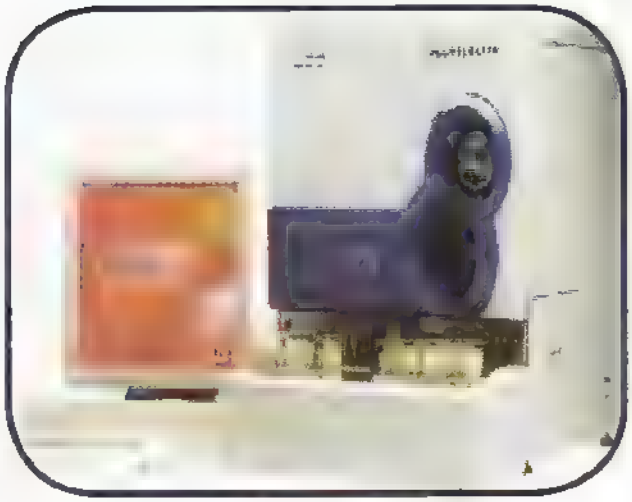


Fig. 4.3: Iris Diagnostics iChem®VelocityTM.

Fig. 4.4: Iris Diagnostics iQ®200SPRINTTM.

Fig. 4.5: Sysmex UF-100® Urine Cell Analyzer.

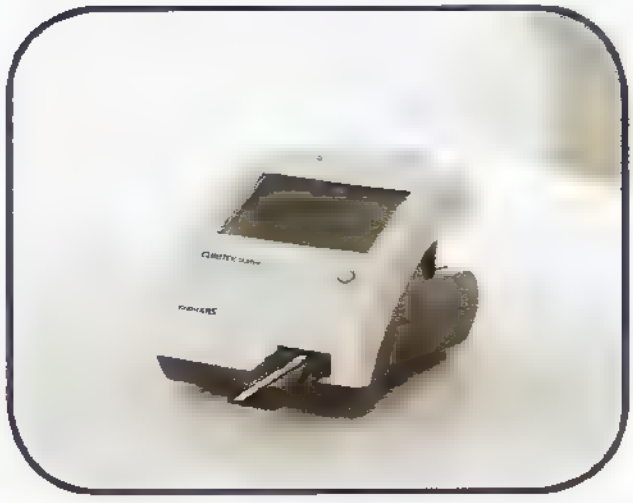


Fig. 4.6: Siemens Medical Solutions Diagnostics manufacturesthe Clinitek® Status.

Abbreviations

Ca	Calcium
E. granulosus	*Echinococcus granulosus*
E. vermicularis	*Enterobius vermicularis*
Fig.	Figure
HPF	High Power Field
LPF	Low Power Field
O. volvulus	*Onchocerca volvulus*
RBCs	Red Blood Cells
g	Gravity
RTE	Renal Tubular Epithelial
S. haematobium	*Schistosoma haematobium*
S. mansoni	*Schistosoma mansoni*
T. vaginalis	*Trichomonas vaginalis*
WBCs	White Blood Cells
W.bancrofti	*Wuchereria bancrofti*

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Atlases and books available from the same author:

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- *Color Atlas of Malaria Microscopy*
- *Color Illustrated Multiple Choice Questions in Malaria Microscopy.*
- *Color Atlas of Mycobacterium tuberculosis Microscopy*
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- *Color Atlas of Medical Bacteriology*
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الدليل العملي في تبسيط علم الاحياء الدقيقة الطبية: علم البكتيريا: الجزء الاول

الدليل العملي في تبسيط علم الاحياء الدقيقة الطبية: علم البكتيريا: الجزء الثاني

- انطلاقا من مجهود شخصي يحرضه حب البحث و الحث على عمومية الاستفادة من المعلومة؛ حاولت جاهدا ان الخص لكم خلاصة تجربة و كينونة روح تتسم بمعنى فضولية الطموح و المعرفة؛ ومهما كان المبذول من جهد سيضل هذا العمل قطرة في بحر اقدمه لكم بكل حب متمنيا لكم الاستفادة منه و باعتباره نقطة انطلاق لحث تفكيركم للمزيد و لا اريدكم ان تجعلوا منه نقطة توقف ... لكل صفحة في عملي هذا ذكرى لزمان ومكان واشخاص و قفوا الى جانبي و استمديت منهم الكثير من الصبر و القوة والحكمة و الاصرار وفي ذات الوقت جعلت نصب عيني ان انتقي واستخلص ما ارجوه ان يكون واضحا و نافعا يفيد الدارس بهذا المجال ليعرف اكثر و يضيف خطوات جديدة الى المشوار الذي خطوت فيه؛ و سنواصل الجهود للنهوض بالمعرفة و المعرفة المختصة في المجال الطبي باعتبارها نبراس الاجيال و طريق هدى نحو الرقي والتقدم و الرفاهية ولن يتأتى ذلك الا بتعاون كل ذي شأن و ان نساعد على انتشار المعارف و تكليل الجهود باستصدارها عملا يخرج للنور وينير درب من يتعطش قلبه للدراية و تحويلها الى فعالية تفيد الانسان صحة و عملا .. لقد تصارعت مع عقبات الواقع كثيرا وفي هذا العمل خصوصا لاستخراجه و وضعه بين ايديكم وبهذه الكيفية والصورة التي اتمنى ان ترضيكم .. ورغم كل ما أشرنا اليه من صعوبات الا ان تلك الصعوبات التقنية و غير التقنية تلبس هذا الاطلس المصور صورة اخرى اكثر بهاء و رونقا ملونة بلون التحدي و الانجاز وتلك القيمة المعنوية لا تقل عن قيمته العلمية ان لم تكن الاكثر سطوعا بين كل الصور. ما قدمناه سيكون مجرد فاتحة لأعمال اخرى باذن الله سنسهر الليال ونطوي المسافات كي ننجزها لينال الدارس فائدتها بمختصر الوقت والجهد.

- هذا وإني لأحمد الله العلي القدير على أن مكنني من إنجاز هذا الاطلس المتواضع الذي ما قصدت منه إلا وجه الله ثم خدمة الطلاب في مجالات الطب وخصوصا طلاب الطب المخبري، فإن أكن قد وفقت فيه فذلك من فضل الله وجوده، وإن كانت الأخرى فحسبي أنني بذلت جهدي وبحثت وما بخلت بطاقتي، والتوفيق من الله... والله من وراء القصد، وهو الهادي الى سواء السبيل.

Color Atlas of Urinalysis